Environment Canada
Environnement Canada

Automated Thermograph Computations

First Edition

INLAND WATERS DIRECTORATE
WATER RESOURCES BRANCH
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CONTENTS

1. INTRODUCTION

This manual was prepared by Messrs. M. Krol and G.E. Lamontagne and approved by Mr. W.J. Ozga, Head, Data Control Section, Water Survey of Canada. It provides the Water Survey of Canada with a set of detailed instructions to automate water temperature computations using a digitizer interfaced with a card punch.

The Water Survey of Canada has been collecting continuous water temperature records at selected gauging stations since 1958 (26 in 1979); the daily maximum, minimum and mean water temperatures were being extracted from the charts by hand. In 1979 it was decided to automate this process using a modified version of the STREAM computer program called TGRAPH. This new program can process records in either degrees Fahrenheit or Celcius and produces computer listings and punched cards of water temperature data only in degrees Celcius. The output cards will be stored in a magnetic tape file which is only in the planning stage at present.

This is the first edition of this manual and will be updated as new or improved procedures are developed.

2. MACHINE CONFIGURATION AND TIMING

The TGRAPH computer program has been tested on the IBM 370 model 168, the CDC Cyber 74 and the Univac 1108. These tests indicate that the program requires 230,000 bytes of memory on an IBM machine and 40,000 words of memory on the CDC and Univac. The peripheral equipment required are a card reader, a line printer, a card punch, a plotter and 4 temporary storage areas for internal computations.

The times required to process 10 stations of test data are as follows:

	Compile Time	Execution Time
IBM 370	45.3 seconds	180.7 seconds
CDC 640	27.5 seconds	36.2 seconds
UNIVAC 1108	99.5 seconds	120.5 seconds

3. GENERAL DESCRIPTION

3.1 Digitizer System

The digitizer system consists of a digitizing table, a control console, a card punch, and an auxiliary keyboard. The auxiliary keyboard is on the digitizing table and it is used to enter reference point information from the recorder chart. The control console acts as the interface between the digitizing table and the card punch, by transferring the co-ordinate position of the cursor on the digitizer table to the card punch. Two 4-digit visual displays register the X-Y co-ordinates of the cursor on the table in tenths of millimetres. A 2-inch diameter pointer (or cursor), which is attached to the table by an electrical cord, is used to manually follow the trace on the chart. A small pushbutton is mounted on the cursor and when pressed causes the contents of the two visual displays to be passed to the card punch.

Before digitizing can start, the recorder charts must be documented. The chart documentation consists of recording the station identifier, the chart range, the time scale, and the water temperature reading and time at the start and end of the chart trace. Any intermediate reference points, such as clock stoppages or pen stoppages must be documented. Reference points which have the day, time and instantaneous water temperature reading as noted by the technician when visiting the gauge site are called check points. Most of the chart documentation should be entered into the digitizer system through the auxiliary keyboard.

Once the chart has been documented, it should then be digitized and digitizing requires that an operator follow a chart trace with the cursor and press the small pushbutton on the cursor at the end of straight-line segments of the recorder chart. When digitizing, the recorder chart may be placed at any angle. To allow for this rotation of the chart, six orientation points are digitized. The orientation points plus the chart scale information are used to compute transformation equations that will transform any X-Y co-ordinate from the digitizer to an instantaneous chart reading of water temperature and time of day. The time correction (or time difference between an observed reading and it's corresponding instantaneous chart reading) is distributed between check points and applied to all computed times between these points, giving a corrected chart time. The paper correction (or temperature difference between the observed temperature reading and the instantaneous chart reading) is distributed between check points and applied to all computed temperature readings between these points, giving an instantaneous temperature reading.

The accumulation of the weighted means of the instantaneous water temperatures divided by 24 gives the daily mean water temperature for one day.

The preliminary results from the digitizer system, shows four months of daily maximum, minimum and mean water temperatures per page. Another option is 6 months of daily maximum and minimum water temperature per page. A plot of the digitized chart and the annual graph of daily mean water temperature can also be produced as an option.

A thorough quality check of the output listings from the digitizer program consists of verifying the check point information and ensuring that it has been keyed in properly. The mean water temperature for at least one day per digitized chart segment should be computed manually for quality checking.

Corrections and manually computed water temperatures (updating corrections) are entered on punched cards, which are added to the deck and used to produce a revised preliminary listing. If these listings are correct, an annual page of water temperature and an annual water temperature graph may be obtained. Punched cards suitable for storage on a magnetic data file can also be produced.

Thus in the Regions, the final output from the digitizer system is an annual printout of daily mean water temperature, a 6 months per page of daily maximum and minimum water temperatures, and annual graph of daily mean water temperature and punched cards. The punched output is processed in Ottawa.

3.2 Orientation Error

The orientation error is related to the accuracy of digitizing the six orientation points on the recorder chart. The more accurate the digitizing the less the error. There must be three orientation points along the top of the chart and three along the bottom and they must be selected on the zero hour (offset by 0.1 inch, see note in 4c) grid lines of the recorder chart. One straight line should pass through the top three points and another straight line should pass through the bottom three points. The distance between the 2 straight lines must be uniform and for an English recorder chart this distance will be 4 inches.

Orientation errors can best be explained with an example. Assume there is an English recorder chart with a vertical range of 80 degrees Fahrenheit and a time scale of 2.4 inches/day. Since the orientation points are on the zero hour (offset by 0.1 inch, see note in 4c) of the day, the three orientation points along the top must be multiples of 2.4 inches or 609.6 tenths of millimetres from each other. Similarly the orientation points along the bottom of the chart must be multiples of 2.4 inches away from each other. Using the above information it is possible to transform each orientation point in tenths of millimetres to a water temperature in degrees Fahrenheit and time in hours that the water temperature occurred. The top three orientation points are given a water temperature of 110 degrees Fahrenheit the bottom three are given a water temperature of 30 degrees Fahrenheit. The first orientation point is given a time of 0 hours and each of the other orientation points has a time in hours relative to the first orientation point. Since each orientation point is assumed to be on the zero hour (offset by 0.1 inch, see note in 4c) grid line of the chart then the times of the orientation points relative to the first orientation point will be multiples of 24 hours. For each orientation point in tenths of millimetres there will now be a water temperature and a time in hours. These new points are called control points. Using the statistical procedure of multiple regression 2 equations can be defined which transform the X-Y co-ordinate pair into a water temperature and a time in hours. Each orientation point is then substituted into the regression equations to see how well the equations represent the water temperature and time in hours. Usually there is a difference between the orientation points which have been transformed by the regression equation and the control points. The orientation error in the digitizer programs is computed using the maximum difference in water temperature multiplied by 2 inches of chart per degree Fahrenheit of water temperature or the maximum difference in time in hours multiplied by 0.1 (time scale of the chart in inches per hour).

Whenever an orientation error larger than 0.02 of an inch results, redigitize the charts ensuring that it is perfectly straight on the table. Otherwise, the water temperature as computed from the regression equation may not give accurate results.

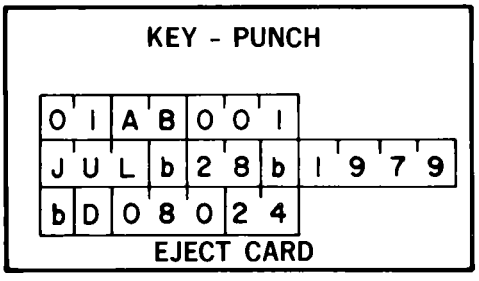
If an orientation error occurs after redigitizing, check the orientation points on the recorder chart to ensure they are multiples of 2.4 inches apart and that the top and bottom orientation points are separated by a uniform distance. Any magnetic substance too close to the digitizing table could affect the magnetic coil in the digitizer and thus the results, and should therefore be removed.

4. CHART DOCUMENTATION FOR DIGITIZING

Control information is required by the computer program so as to process the recorder charts. The control information includes a station identifier, the time scale, the range of the chart, the drive of the recorder at the beginning of the trace, orientation points to correct for the rotation of the chart on the table, the date of the first orientation point and lastly a point with a known temperature reading.

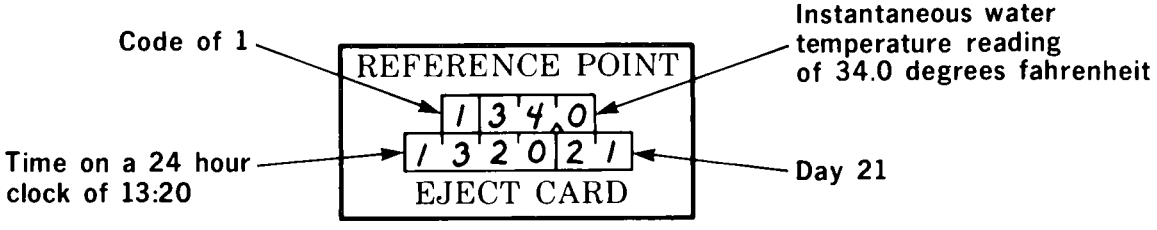
Three types of rubber stamps are required to prepare charts for digitizing:

(a) "Chart Initial Orientation" Stamp



The information on this stamp is entered onto a card by using the Univac card punch. The chart initial orientation stamp contains information which is relevant to the whole chart. This stamp contains the station number, the date of the first orientation point, the pen drive at the time the trace begins, the vertical range of the chart, in Fahrenheit for an English chart or in celsius for a metric chart, and the horizontal time scale. The first orientation point at zero hour (offset by 0.1 inch, see note in 4c) may be on any day before or after the trace begins. It is simply necessary to indicate the date on which this first orientation point falls, which need to be the day on which the trace begins. Only the first three letters are used to abbreviate any month.

(b) "Reference Point" Stamp



Within this stamp provision has been made for a one-digit reference point code, the instantaneous water temperature reading, the time based on the 24 hour clock and the day on which the reference point falls. The information on this stamp is entered by using the auxiliary keyboard and refers to only one specific point on the chart. The instantaneous water temperature reading may be either positive or negative, but if it is negative the minus sign should immediately follow the reference point code. The meanings of the various codes are as follows:

1 - for an observed point or simply a check point;
2 -

3 - for a point at the end of a continuous trace which is followed by a break in the trace which has not altered the chart time and the trace begins again within the same orientation region;
4 -
5 -
6 - for a point at which the pen has been reset in direct drive;
7 - for a point at which the pen has been reset in reverse drive;
8 - for a point at which the digitizing of the trace is to continue after the chart has been moved on the digitizer table and re-oriented;
9 - for a point at the end of a chart trace segment.

(c) "Documented By" Stamp

Documented by	_____	Date _____
Digitized by	_____	Date _____
Quality Check by	_____	Date _____

This stamp is used as a quality control and contains the three entries "documented by", "digitized by" and "quality check by" together with their respective dates.

The "working area" of the digitizer table is 100 x 100 cm. Because the recorder chart may be placed randomly on the table at any angle, the computer program has been written to expect six points, called orientation points, to be used to determine the amount of stretch or shrinkage of the chart and to determine the angle of rotation. These six orientation points, 3 along the top and 3 along the bottom, must be selected on the zero hour (offset by 0.1 inch, see note below) grid lines of the chart. Each of these should be circled and labelled O.P. for orientation point so that they stand out and lessen the possibility of digitizing the wrong point. With the usual time scale the 6 orientation points should span about 14 days. This may be increased to a maximum of 16 days or decreased to a minimum of 2 days, as could be the case at the end of a chart. When the end of an orientation occurs within a chart a reference point with a code of 8 must be placed on the trace between the last set of orientation points on the zero hour (offset by 0.1 inch, see note below) grid line.

NOTE: In the Water Level Recorder with Thermograph, the thermograph pen uses four inches on the right side of the recorder chart. It is offset 0.1 inch on the time scale to allow the water level pen to pass readily. Orientation points should therefore be 0.1 inch to the right of the water level orientation point.

4.1 Examples of Chart Documentation

The following examples suggest ways in which the information contained on the recorder charts may be coded so that it will be correctly interpreted by the computer program.

4.1.1 Several Orientations for a Chart

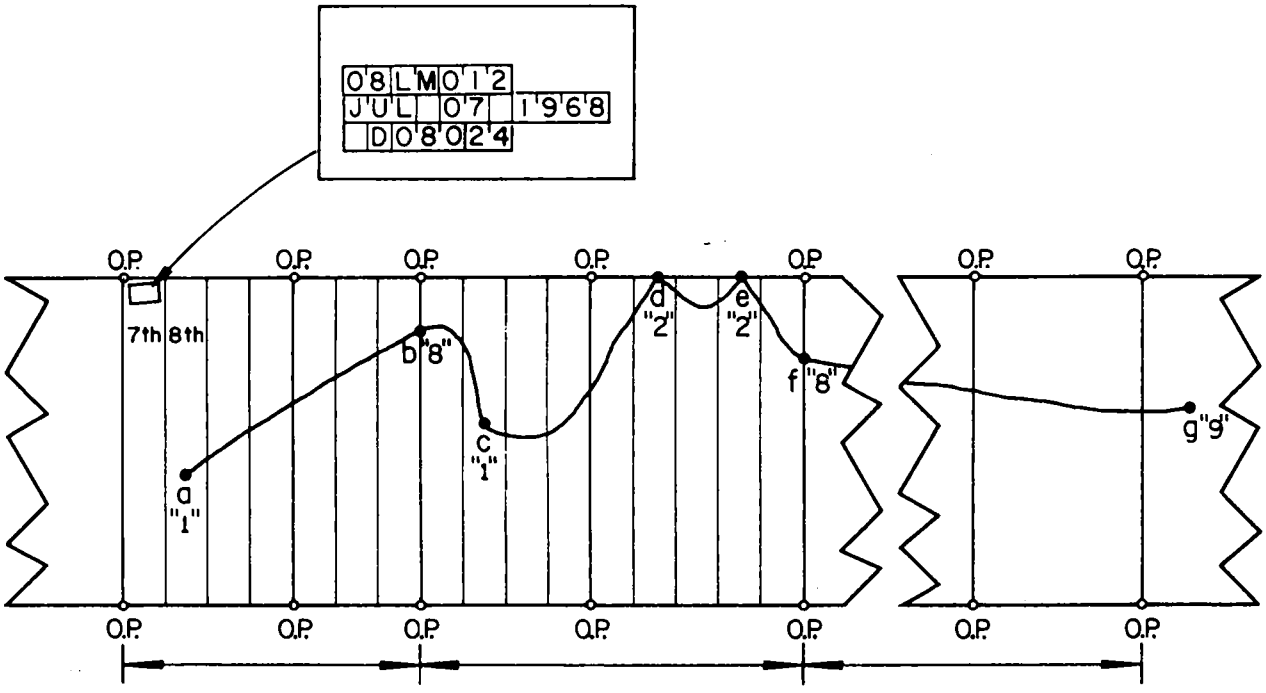


FIGURE 1

The chart segment as shown in figure 1 is assumed to be several times longer than the digitizer table. The points at "a", "c" and "g" have observed data associated with them, i.e., the water temperature and time is available from an observation. The points at "a" and "c" are simply check points so they are coded with a "1" but the point at "g" is the last point on the chart trace and therefore is coded with a "9".

The points at "b" and "f" are points at which the chart must be moved on the table for re-orientation because the chart is so long. These points are at zero hour (offset by 0.1 inch, see note in 4c) of a day close to the end of the working area of the table and are thus given a code of "8". After reaching point "b", move the chart along the table, re-orient the chart and resume digitizing starting at point "b". When the point "b" is digitized the second time it is not given a code of 8. This same procedure is followed at the point "f".

4.1.2 Deleting a "Short" Period of the Record

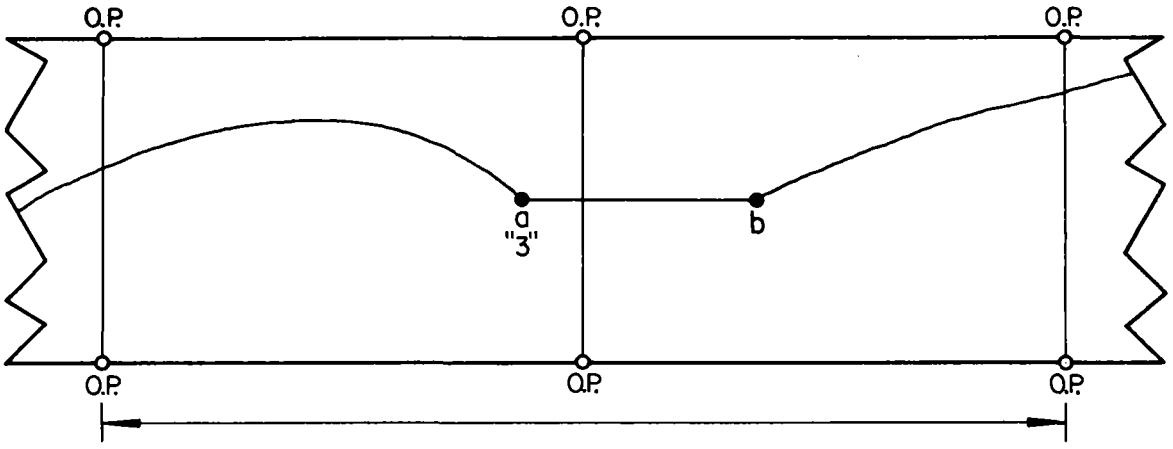


FIGURE 2

To delete a "short" period means that all the trace to be deleted falls within the span of one orientation. The chart illustrated in figure 2 contains a "short" period of record from points "a" to "b" which should be deleted. This portion is excluded by giving "a" a code of 3 and then continuing to digitize at "b" which is not given a code. The movement of the paper was not interrupted between the points "a" and "b" so "b" has the correct chart time, and the paper and time corrections can be computed as usual.

4.1.3 Deleting a "Long" Period of the Record

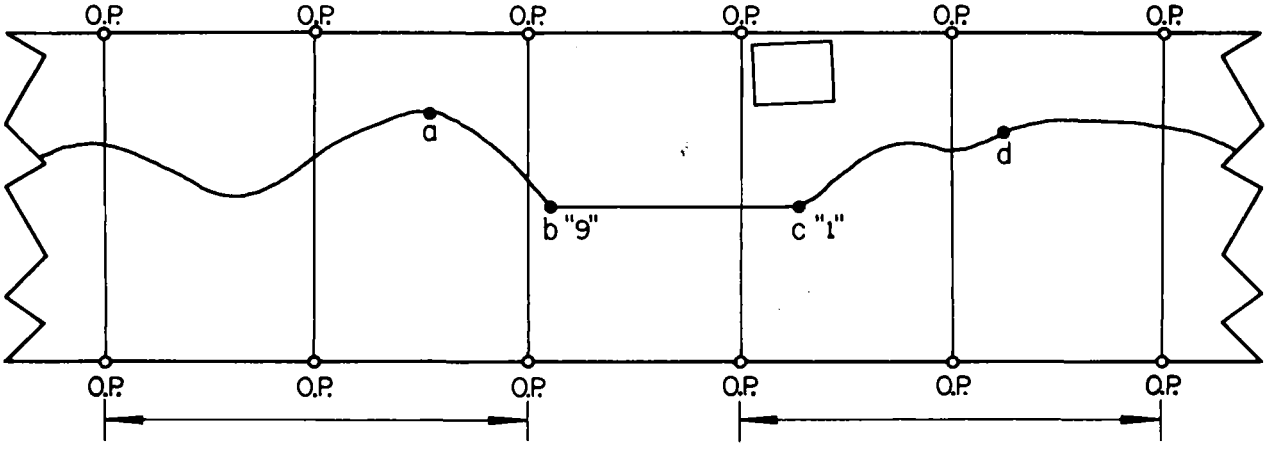


FIGURE 3

To delete a "long" period of record means that all the trace to be deleted will not fall within the span of one orientation. Figure 3 is the same as figure 2 except that the portion of the record to be deleted is so long that the chart must be moved on the table for re-orientation. When this situation arises point "b" should be given a code of "9" preferably with a "manually computed" temperature

reading and time. Thus point "c" is treated as though it were the beginning of a new chart and similarly should be supplied with a "manually computed" temperature reading and time. If the "manually computed" readings are not supplied at "b", the time and paper corrections for this point will be the same as those computed at the preceding check point, "a". Similarly if the "manually computed" readings are omitted for "c" the time and paper corrections for this point will be the same as those at the next check point, "d".

4.1.4 Pen Reset

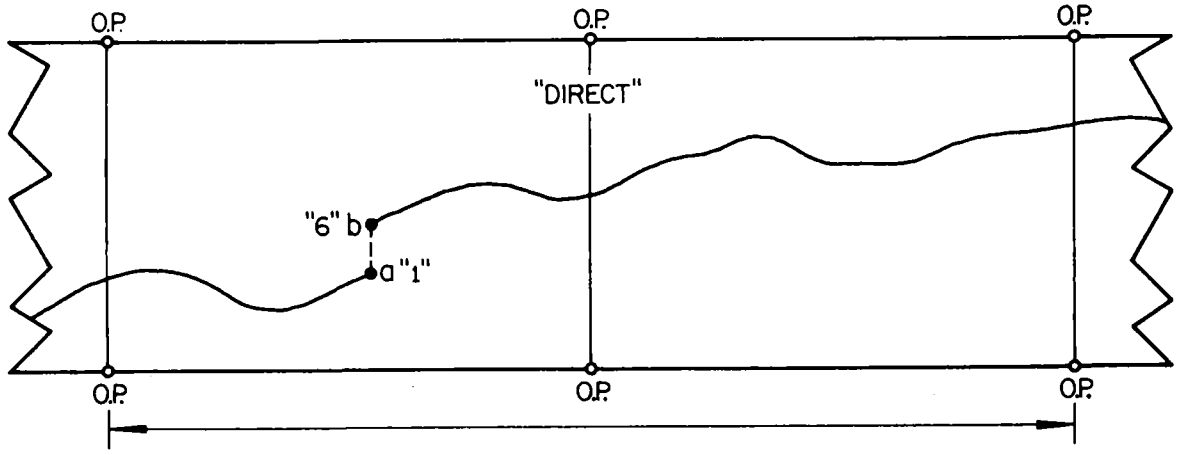


FIGURE 4

Figure 4 shows a record on which at point "a" the pen was manually reset to point "b" by the observer and the drive remained direct, without disturbing the movement of the paper. Normally the observer will have observed readings for both "a" and "b". Point "a" is given a code of 1 as an ordinary check point. Point "b" is given a code of 6 because the recorder is in direct drive at that point. Had the pen been in reverse drive at point "b" it would have been given a code of 7. It is not necessary to give point "a" a code if no observed readings are available. But if "a" is given a code when observed readings are missing then the space for them is left blank.

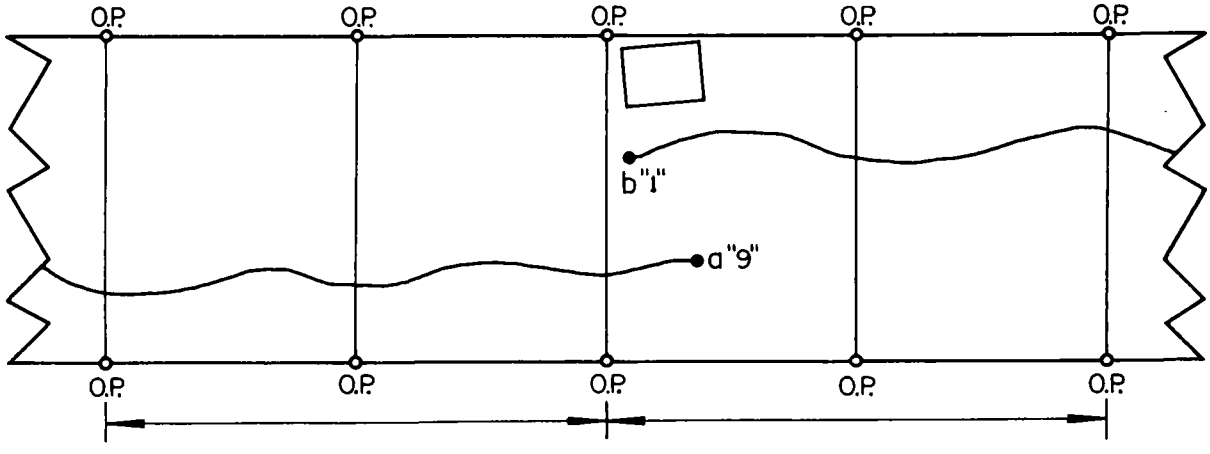


FIGURE 5

The program handles codes 6 and 7 just as if a new chart was started at point "b" (i.e., just as if "a" had a code of 9 and a chart initial orientation was performed before digitizing point "b"). The paper and time corrections computed up to point "a" are not carried to point "b". A completely new set of corrections is used from "b" on, just as if "b" belonged to another chart. Thus the use of codes 6 and 7 saves orienting the chart.

If the clock was running fast before the pen was reset at point "b", it would fall behind point "a" on the recorder chart. If point "b" is behind point "a" by an amount greater than 0.5 hours, as in figure 5, it will be necessary to give point "a" a code of 9 and "b" a code of 1 and go through the procedure for a chart initial orientation before reading point "b".

4.1.5 Break in Time - Clock Stopped

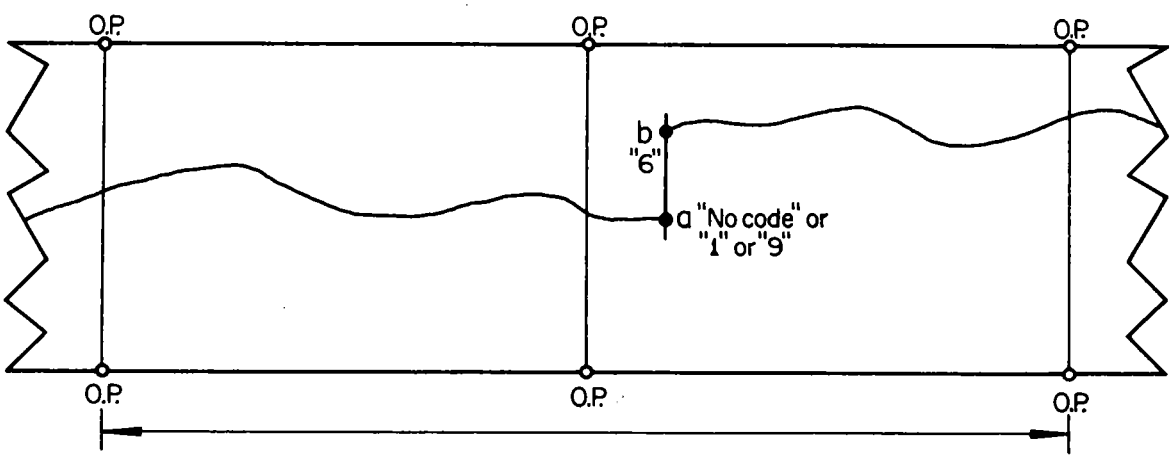


FIGURE 6

To illustrate this refer to figure 6 where there is a break in time between point "a" and point "b" such that the paper stopped moving at "a" but started again at "b". Observed readings are normally not available for point "a" but point "b" usually has observed readings if the observer re-started the clock.

If the break in time is less than 14 days this situation is handled in the same way as the pen reset in figure 4. The difference will be that the time corrections for point "b" and all points following it will include the break in time between points "a" and "b".

If no observed readings are available for point "a", the point "a" and the points preceding it will have the same time and paper corrections as the last check point appearing before "a". If no observed readings are available for "b" then point "b" and the points following it will have the same time and paper corrections as the first check point following "b". Note that paper and time corrections are not carried across the break. Point "b" is given a code of 6 if the drive is in direct or a 7 if the drive is in reverse.

If the break in time is larger than 14 days the break in time is handled the same as an end of chart. First, point "a" is given a code of 9 and then a chart initial orientation is performed before digitizing point "b". In other words, the

data are handled in exactly the same way as if the points from "b" on were on a different chart. If no observed readings are available for point "a" then point "a" and the points preceding it will have the same time and paper corrections as the last check point appearing before "a".

4.1.6 Break in Time - New Chart

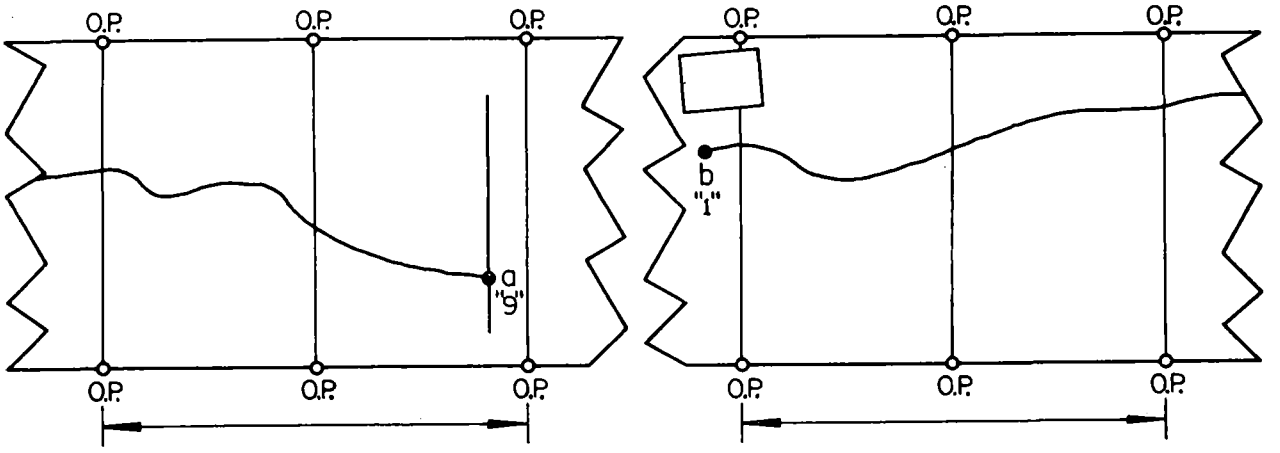


FIGURE 7

This is a particular case of a break in time due to clock stoppage as explained above and can be considered in the same light as a break in time of 14 days or more. As depicted in figure 7 the clock remained stopped until the observer arrived, changed the chart and started the clock again. Thus the point "a" is supplied with a code of "9" and the point "b" is treated as though it were the first point of a new chart. If no readings are computed for point "a", then point "a" and all the points preceding it will have the same time and paper corrections as the last check point appearing before "a".

4.1.7 Shift in Water Temperature Record

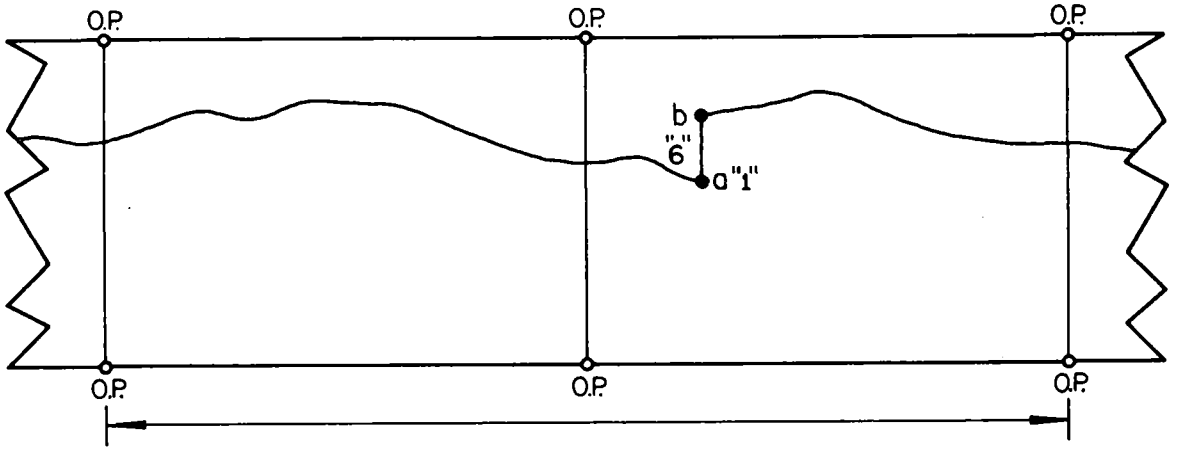


FIGURE 8

A sudden shift in the chart trace due possibly to chain slippage on the pulley is illustrated in figure 8. In this example the water temperature at point "b" is actually the same as it is at point "a" but normally there are no observed readings for either of these points. In the manual computations a constant correction is subtracted from point "b" and all the points following it; thus to simulate this correction within the computer program these two points are supplied with the same "manually computed" readings. Thus point "a" is given a code of 1 and point "b" is given a code of "6" and both become check points because "manually computed" readings are available.

4.1.8 Missing Observed Readings

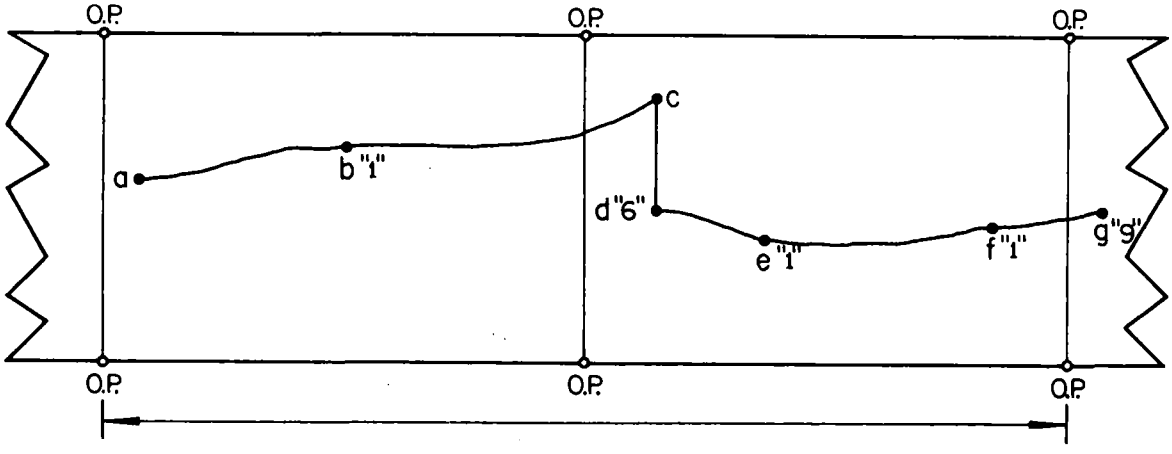


FIGURE 9

Consider a hypothetical case as illustrated in figure 9 where the points "b", "e" and "f" have observed readings and have been assigned a code of 1 but the points "a", "c" and "g" do not have observed readings. The point "a" is the first point on the chart and would normally be assigned a 1 code with observed readings but for this hypothetical example a 1 code has not been assigned to "a". The point "d" represents a pen reset and thus has been given a code of 6 and the point "g" has been assigned a 9 code because it is the last point of the chart.

The program will compute time and paper corrections for points "b", "e" and "f" which are the only reference points with observed readings, (i.e., the only check points). By definition a check point is a reference point with observed readings. Since "b" is the first check point on the chart, it will have a zero paper correction. Point "e" will also have a zero paper correction because it is the first check point after the code 6 reference point at "d". The code 6 reference point has the same effect as if a new chart had been started.

Points from "a" to "b" will have the same time and paper corrections as point "b" which is the first check point on the chart. Similarly points from "d" to "e" will have the same time and paper corrections as point "e" which is the first check point after the code 6 reference point at "d". Points from "b" to "c" will have the same time and paper corrections as point "b" which is the last check point before the code 6 reference point at "d". Similarly points from "f" to "g" will

have the same time and paper corrections as point "f" which is the last check point before the end of the chart. The corrections for each digitized point from "e" to "f" will be calculated in the usual manner by interpolating between the corrections for the points at "e" and "f".

The program prints out the warning message "check above point for observed readings" for points "a", "d" and "g" because these points would normally have observed readings. In the above example, if point "b" did not have observed readings the program would print out the error message "no observed readings for this record" and the data from points "a" to "c" would be deleted. The program would be unable to compute water temperatures between these points.

4.2 Time and Paper Corrections

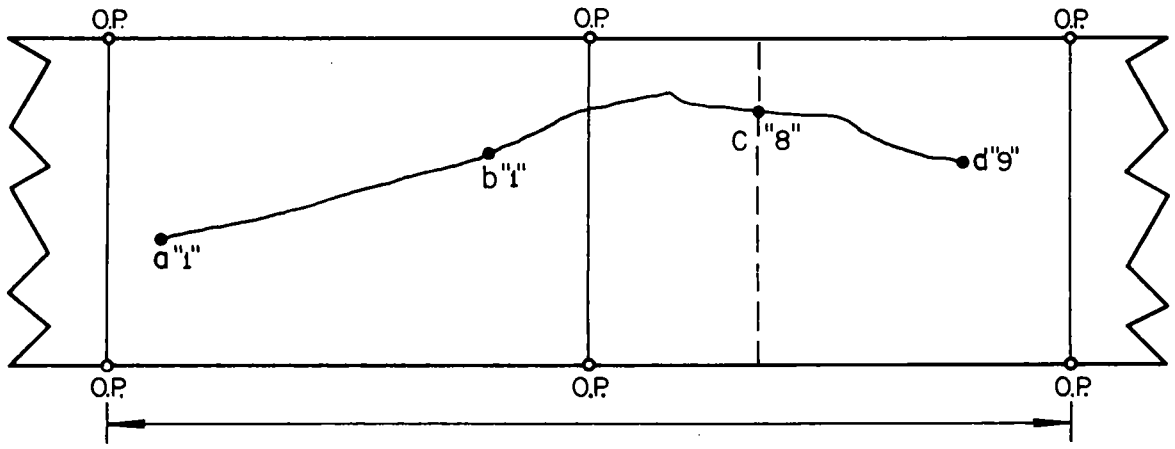


FIGURE 10

Time and paper corrections are computed at each check point, i.e. at each point for which observed readings are available. The program interpolates time and paper corrections between check points in proportion to the chart time, that is, the distance along the time axis of the chart.

Time and paper corrections are worked out separately for each chart, from the point following the chart initial orientation to the point with a code of 9 indicating the end of the chart. For time and paper corrections codes 6 and 7 have the same effect as starting a new chart, because all points following a code 6 or 7 are treated as though they were on a separate chart.

If the first point at the beginning of a chart or following a pen reset is not a check point in that it does not have observed readings, that point and all the points following it will have the same time and paper corrections as the first check point encountered. If the last point on a chart (code 9) or the point preceding a code 6 or 7 point does not have observed readings, then the program assumes that all points following the last check point are to have the same paper and time corrections as that last check point. Both of these cases are covered in the preceding section "Missing Observed Readings".

The program computes the chart time directly from the co-ordinates together with the data supplied initially such as the date and time scale on the "Chart Initial Orientation" card (79-027). The time corrections are computed as in the manual computations and are applied to each digitized point.

The chart water temperature reading cannot be computed directly because the program is not given the temperature reading at the bottom of the chart. The program relates co-ordinates to the water temperature by making the chart reading of the first check point equal to the observed readings. The first check point at the beginning of a chart or after a break and thus coded with a 6 or 7 always has a zero paper correction for this reason. It is also for this reason that the program must have at least one check point to be able to compute the water temperature. An error message is printed out if a chart does not have a check point.

Figure 10 shows a segment of an English chart where the first point "a", the point "b" and the last point "d" are check points, i.e. they have observed readings. The point "c" is a re-orientation point. Assume that the bottom of the chart reads 30.0 and that the range of the chart is 80, i.e. 4 inches=80 degrees Fahrenheit. The table below shows the relevant readings for water temperatures.

Point	Drive	Code	Observed Readings	Chart Readings	Paper Correction	Inches from Bottom of Chart
"a"	D	1	42.0	42.0	0.0	0.64
"b"	D	1	65.0	64.6	0.4	1.77
"c"	D	8	-	100.0	-	3.50
"d"	D	9	89.0	89.2	-0.2	3.00

Note that although point "a" was read at 0.64 inch from the bottom of the chart its chart reading was computed as 42.0 degrees Fahrenheit because the program always makes the chart reading of the first check point equal to the observed readings. The paper correction of the first check point of the chart is thus always zero. In the above example, all chart readings will be 0.8 degree Fahrenheit lower than the values computed for the "inches from the bottom of the chart". Point "b" was read at 1.77 inches but its chart reading is computed as 64.6 degrees Fahrenheit. Its paper correction is the observed reading of 65.0 degrees Fahrenheit minus the computed chart reading of 64.6 degrees Fahrenheit giving 0.4 degree Fahrenheit. Thus point "d", 1 inch down from the top of the chart, would give a chart reading of 90.0 degrees Fahrenheit. But the shift resulting from making the chart reading of point "a" equal to the observed reading as 0.8 degree Fahrenheit. Thus the program will compute the chart reading as 90.0 degrees Fahrenheit minus 0.8 degree giving 89.2 degrees Fahrenheit. The paper correction of point "d" will then be -0.2 degree Fahrenheit.

The paper corrections are not printed out for points that do not have observed readings. The program computes the paper correction of point "c" by interpolating the new paper corrections of points "c" and "d" with respect to the chart time; that is, the distance along the time axis of the chart. The same applies to all other points on the chart.

Time corrections are handled in the same way as paper corrections with the exception that the chart time is always the actual chart time and the corrections are applied to this. The program does not make the chart time of the first check

point equal to the observed time. The chart time is obtained by the program from the fact that the first orientation point is at zero hour of the day in the chart initial orientation stamp. The time correction of all check points in the reference point summary is the observed time minus the computed chart time. Thus if the pen is set in error by one hour this one hour time correction will be applied to all the points so that the chart time plus the time correction will yield the observed time.

Similar calculations would be carried out if a metric chart were used as input.

5. HARDWARE DESCRIPTION

5.1 Gradicon (GRAphic to DIgital CONverter) Digitizer

The Gradicon is intended to be used for fast accurate conversion of graphic data to digitial form. Its use in our digitizer system is to convert the water temperature recorder charts to a digital format suitable for computer processing.

A typical Gradicon system includes the following main assemblies:

(a) The table assembly, Figure 11, which holds the servo-mechanism. The servo-mechanism follows the cursor by driving itself along two sets of carrier rails, one set in the X-direction and the other in the Y-direction. The drive mechanisms are connected to shaft encoders which record the position of the servo-mechanism as X and Y co-ordinates. Tables are adjustable in height and tilt to suit the operator's preference; larger models may be power operated.

(b) The display/control console, Figure 12, which provides visual display of the coordinate data and which carries the controls necessary for operation.

(c) The auxiliary keyboard, Figure 11, which allows the operator to enter additional information such as reference point data.

The use of Gradicon requires familiarity with the following buttons on the control console. While reading, refer to Figure 12.

(a) The A/C power control circuit breaker is located at lower left corner of the control console and it must be turned upwards to supply power to the entire control console.

(b) The Power pushbutton controls the A/C power to the display portion of the control console.

(c) The System Reset pushbutton resets the circuit logic in the control console. This pushbutton should be pressed whenever the control console is turned on.

(d) The Record Mode pushbuttons allow the desired mode of operation. The functions of the most frequently used record mode pushbuttons are:

- To generate co-ordinate data for each operation of the cursor pushbutton. To accomplish this press the Point pushbutton.

- To generate co-ordinate data as a function of time for as long as the cursor pushbutton is down. To accomplish this press the Time pushbutton, adjust the rate control which has a range from 0.5 to 20 readings per second, and hold the cursor pushbutton down.

(e) The Absolute pushbutton establishes the co-ordinate data relative to a fixed, pre-established origin on the table.

(f) The Delta pushbutton establishes a new origin, after each reading is taken. Thus the data is relative to the position of the previous point.

(g) The X, Y pushbuttons reset the displays to zero. When establishing the origin, the cursor is placed over the desired point and the X, Y pushbuttons are pressed.

(h) The Scale switch may be used to scale the data by factors of 1:1, 1:2 or 1:4. In the 1:2 and 1:4 positions, the output data represents 1/2 or 1/4 of the true distance on the table.

(i) The Utility counter is a 6-digit counter which contains a 2-digit counter A for the number of X-Y co-ordinates on a card and a 4-digit counter B for the card number.

(j) The Run/Preset/Clear switch has three separate functions. In the Run position the utility counter is incremented by 1, in the Preset position the utility counter is set using the six pushbuttons beneath the utility counter, and in the clear position the utility counter is zeroed.

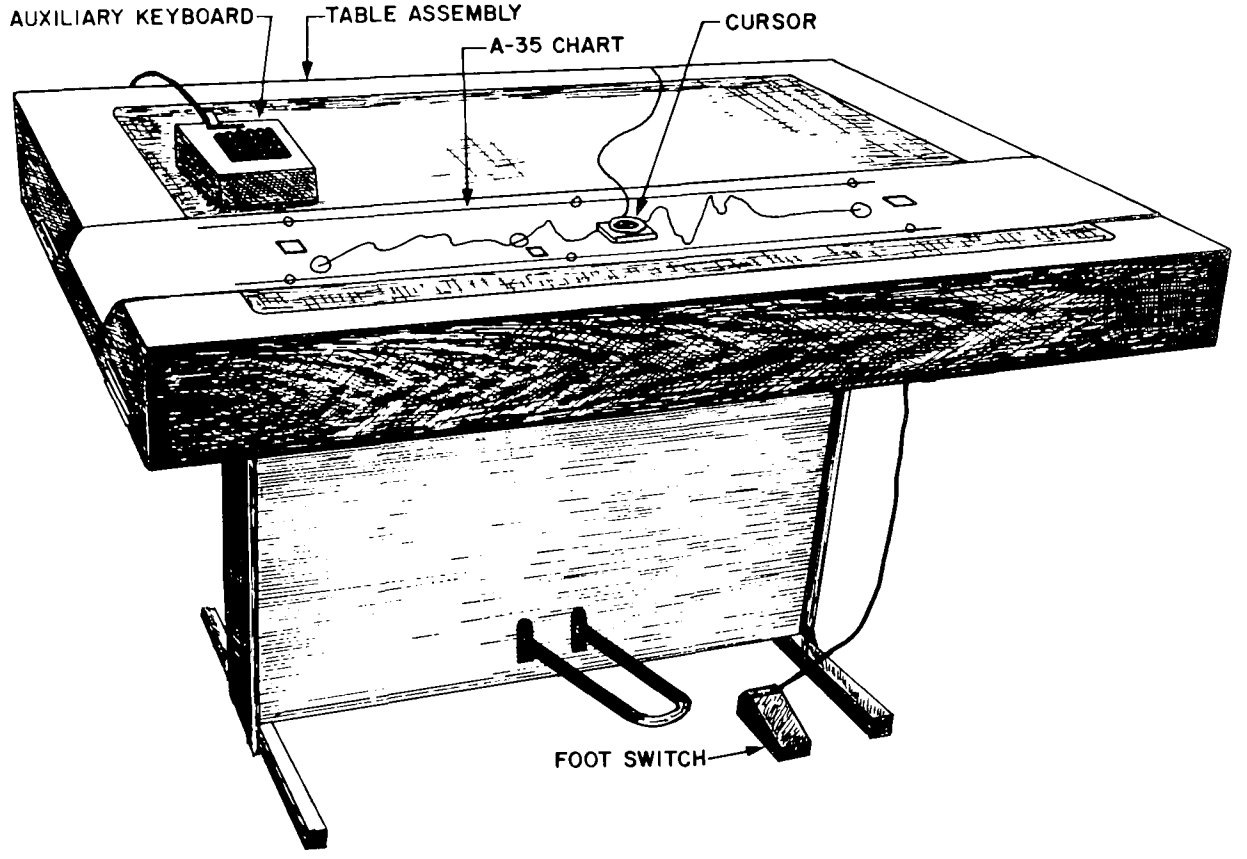


FIGURE II

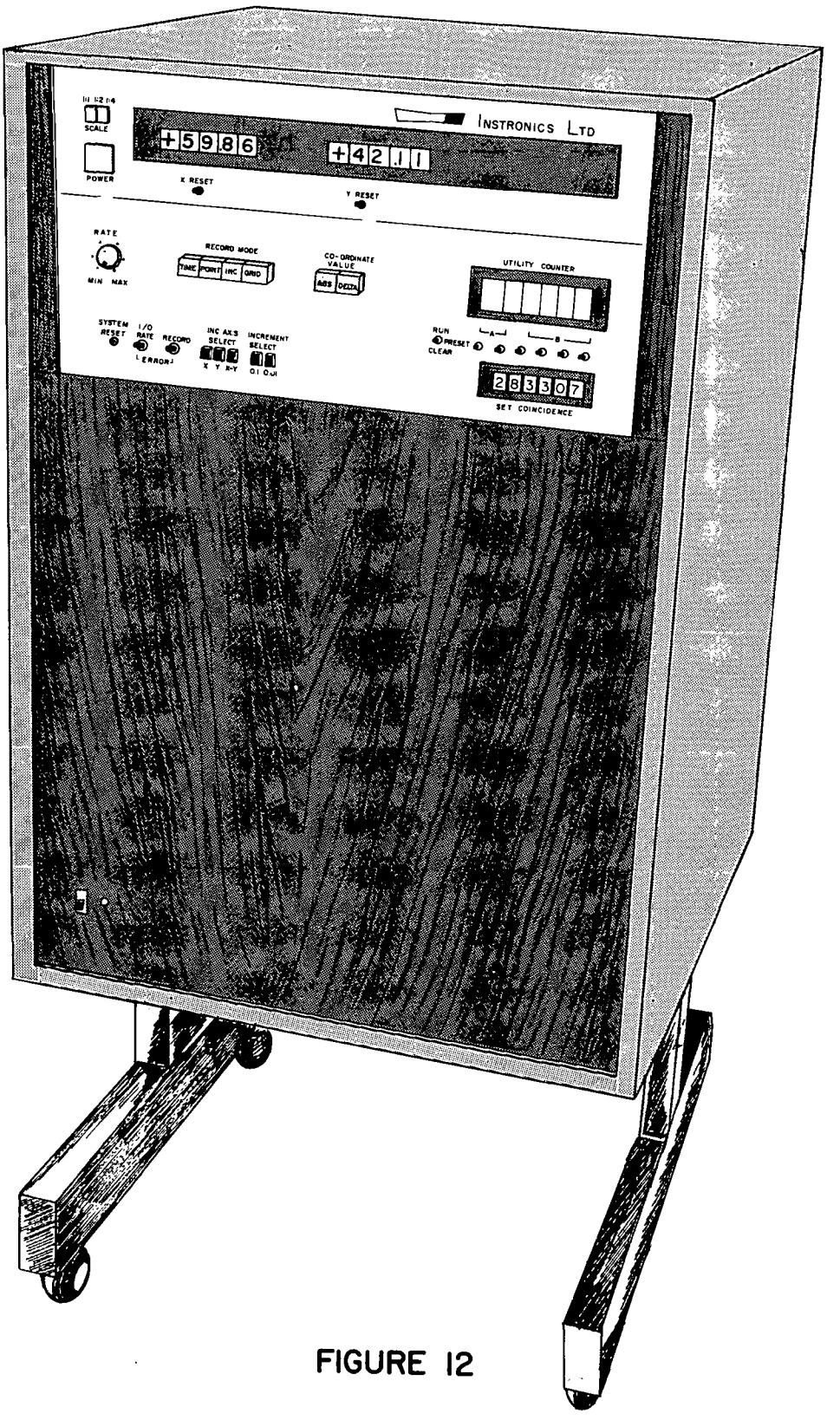

SCALE
POWER
INSTRONICS LTD
+5986
+42.11
X RESET
Y RESET
RATE
MIN MAX
RECORD MODE
TIME
POINT
INC
GRID
CO-ORDINATE VALUE
ABS
DECR
UTILITY COUNTER
SYSTEM RESET
I/O RATE
ERROR
RECORD
INC AXIS SELECT
X Y X+Y
INCREMENT SELECT
RUN
PRESET
CLEAR
A
B
283307
SET COINCIDENCE

FIGURE 12

5.2 Univac 1710 VIP-04

The Gradicon System passes the X-Y co-ordinate position of the cursor to the Univac 1710 VIP Model 04 where the information is punched on a card. The Univac 1710 VIP-04 (Figure 13) has a 64-character binary coded decimal set with an 1100 keyboard and C1339-02 printwheel. For detailed instructions on the use of the Univac 1710-04 VIP refer to the Univac 1700 series operating instructions.

Each column of a card can contain up to 12-punches. A punch in the top row is called a 12-punch. An 11-punch is in the second row from the top, a 0-punch in the third row, a 1-punch in the fourth row and so on to the 9-punch which is in the bottom row. Each column on a card can contain 1 character from a character set. Every character has a unique combination of the 12 possible row punches. For example the letter "B" is a combination of a 12-punch with a 2-punch in the same column.

In order to have the Univac 1710 Card Punch operate under the control of a program card set the Load Prog/Load Data Switch to Load Prog, set Print/Off switch to Print, set Punch/Verify switch to Punch, set Auto/Manual switch to Manual, insert the program card into the Auxiliary Feed and press the Feed Key. The program will be loaded into memory and the card automatically selected to the back stacker. The Load Prog/Load Data switch must now be turned off. Press the Feed Key and a card will be fed into the machine. The red light will come on so simply press the Clear button. Put the keyboard into alphabetic or numeric definition depending upon the first character to be punched on the card. Keypunch in the first card, set the Auto/Manual switch to Auto, and press the Feed key. When this is done the Univac 1710 will be under program card control. To have the Univac 1710 under program card control means there is available 1) automatic selection between alphabetic or numeric data or 2) automatic duplicating or 3) automatic skipping.

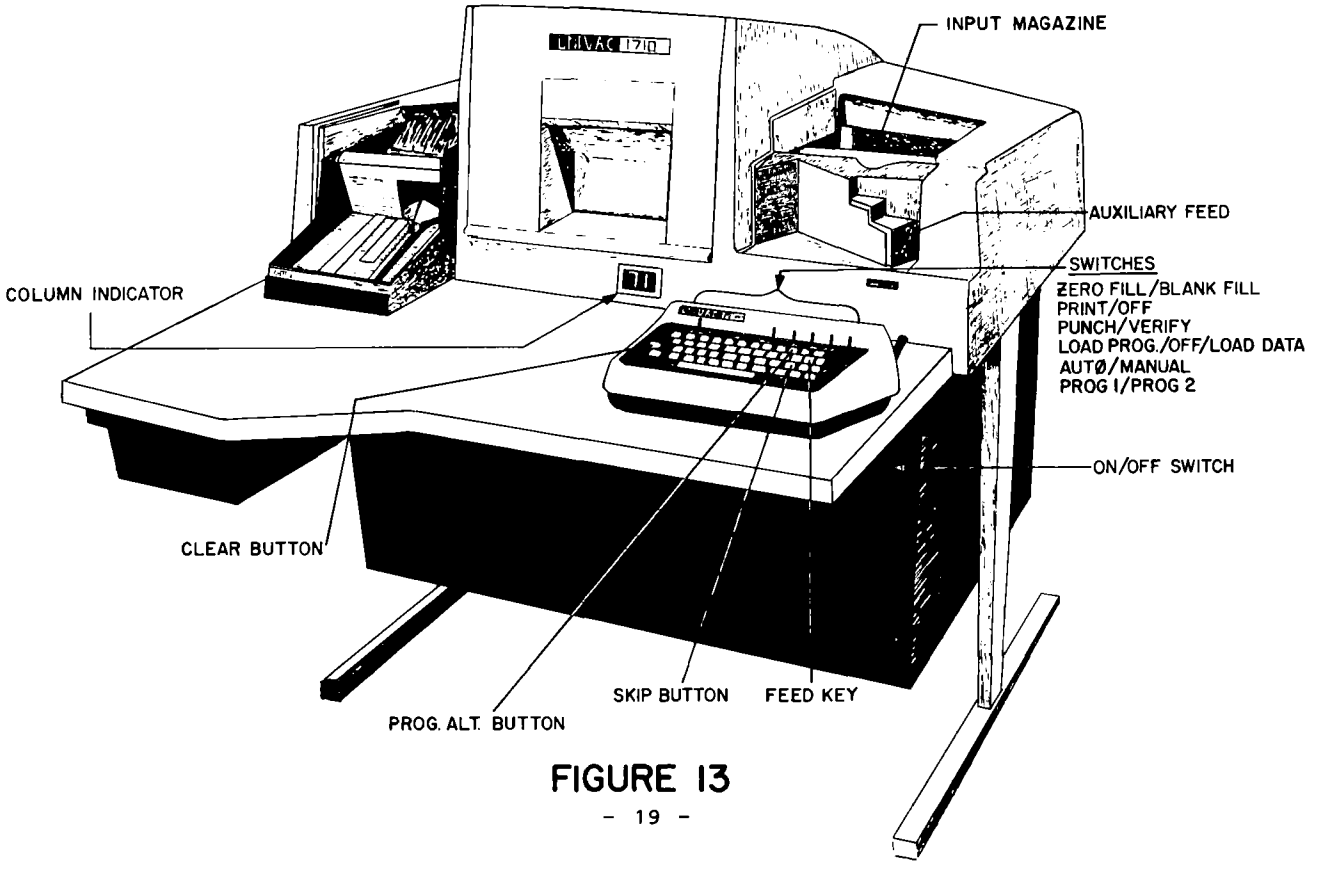


FIGURE 13

6. OPERATING INSTRUCTIONS FOR DIGITIZING A CHART

6.1 Initial Hardware Set-up

6.1.1 Univac 1710 VIP Card Punch

1. Set On/Off (Power) switch to On.
2. Place cards in the input magazine (hopper).
3. Set Zero Fill/Blank Fill switch to Blank Fill.
4. Set Print/Off switch to Print.
5. Set Punch/Verify switch to Punch.
6. Set Load Prog/Off/Load Data switch to Off.
7. Set Auto/Manual switch to Manual.
8. Set Prog 1/Prog 2 switch to Prog 1.
9. Press Skip key twice to clear previously stored data.
10. Set Load Prog/Off/Load Data switch to Load Prog.
11. Insert Digitizer program card into the auxiliary input.
12. Press Feed key; the program card will be loaded into memory and automatically sent to the back stacker; this program is set to punch numerics and alphabetics in specific columns and thus it is not necessary to press either the Alpha or Numeric key when entering the station number, date, scale or drive.
13. Set Load Prog/Off/Load Data switch to Off.
14. Press the Feed key and a card will be fed into the visible station; the red light will come on so press the Clear key to release the keyboard interlock.

6.1.2 Gradicon Control Console

15. Raise the Circuit Breaker located at the lower left-hand corner.
16. Press the Power pushbutton of the Display if not visible.
17. Press the System Reset pushbutton.
18. Set the Scale switch to 1:1.
19. Position the cursor in the lower left-hand corner of the table just within the working area and press the X and Y Reset pushbuttons to establish the origin in the lower left-hand corner of the table.

20. Enter the last two digits of the year of the data by means of the two leftmost thumbwheel switches on the auxiliary keyboard.

21. Set the Record Mode pushbutton to Time or Point (if on Time mode set the Rate).

22. Set the Co-ordinate Value pushbutton to Abs.

23. Press the Run/Preset/Clear switch down to clear the utility counters (it will return to the Preset position). The 4 pushbuttons on the right are used to set the card number at any desired value which must be more than zero and is usually set at 1. Now press the Run/Preset/Clear switch up to Run so the card counter will accumulate.

6.1.3 Univac 1710 VIP Card Punch

24. Set the Auto/Manual switch to Manual.

25. Punch the first digit of the station number in column 1. Set the Auto/Manual switch to Auto. Continue punching the station number. Column 8 should be skipped automatically and stop at column 9. If this does not happen the program card has not been entered properly.

26, English Chart:

Finish keypunching the date, the mode of operation of the chart at the beginning (D for direct or R reverse), the chart range in degrees Fahrenheit and the time scale in inches per day on the "Chart Initial Orientation" stamp.

Example: MAY 04 1971 D08024. i.e. 80 degrees Fahrenheit and 2.4 inches/day.

27. Metric Chart:

Finish keypunching the date, the mode of operation of the chart at the beginning (D for direct or R reverse), vertical range of the chart in degrees Celsius and the time scale in centimetres per day on the "Chart Initial Orientation" stamp.

Example: MAY 04 1971 D04506, i.e. 45 degrees Celsius and 6 cm/day.

28. Press Prog Alt key to allow data to be transferred from the Gradicon digitizer.

6.2 Gradicon Digitizer Table

29. Press the Skip key on the auxiliary keyboard to eject the card containing the information on the "Chart Initial Orientation" stamp.

30. Place the recorder chart in the working area of the table.

31. Digitize the 6 orientation points, 3 along the top and 3 along the bottom, in a clockwise manner, starting with the top left most orientation point.

If this is the first orientation for the chart, then the first orientation point must be at zero hour (offset by 0.1 inch, see note in 4c) of the day punched in the "Chart Initial Orientation" card (79-027). If this is a re-orientation, then the first orientation point must be at zero hour (offset by 0.1 inch, see note in 4c) of a day with a code "8" reference point.

32. If this is a re-orientation then go to step 33. If this is the initial orientation then digitize the first point at the beginning of the trace. If this first point is a reference point, as is usually the case, press the Skip key on the auxiliary keyboard to eject the card, punch the data in the reference point stamp, press the Skip key on the auxiliary keyboard to eject the card and go to step 34.

33. Begin digitizing at the exact location of the code 8 reference point.

34. Continue digitizing the trace until a reference point is found.

35. All reference points are handled in the same manner:

(a) Digitize the position of the reference point.

(b) Press the skip button on the auxiliary keyboard to eject the card.

(c) Punch the following data in the Reference Point stamp

- the code for the reference point.

- the observed data. If there are no observed data then this field is left blank.

Example: code: 9 for the end of a chart,
temperature reading: 800, for 80.0 degrees Fahrenheit,
time: 1430 for 2:30 pm,
day: 02 for the second day of the month.

(d) Press the skip button on the auxiliary keyboard to eject the card.

36. Steps 34 and 35 are repeated until the end of the chart is reached. Then to handle another chart steps 26 to 36 are repeated.

37. To stop the card punch and the digitizer after the last chart has been processed simply:

(a) Lower the Circuit Breaker on the control console.

(b) Set the Auto/Manual switch to Manual.

(c) Press the Eject button.

(d) Raise the hood or turn the Circuit Breaker off on the card punch.

6.2.1 Codes for Reference Points

1 - for an observed point or simply a check point.

2 -

3 - for a point at the end of a continuous trace, i.e. this point is followed by a break in the trace.

4

5

6 - for a point at which the pen has been reset in direct drive.

7 - for a point at which the pen has been reset in reverse drive.

8 - for a point at which digitizing the trace is to be continued after the next orientation, starting with the "0" hour.

9 - for a point at the end of a chart trace segment.

6.2.2 Digitizing the Various Types of Reference Points

Code

1-7 Reference points in this range are handled as in step 35, and digitizing is resumed at the next point after the reference point just processed. The next point after a reference point is simply any point on the chart trace beyond the reference point such that the straight line joining these 2 points very closely approximates the actual trace. In the case of a "code 3" reference point before a break the next point to be digitized is the first point after the break. If two reference points are together such as a "code 1" and a "code 6" at pen reset, then step 35 is simply repeated twice. Thus the sequence is: digitize the position of the "code 1" reference point, eject, punch the "code 1" and any observed data, eject, digitize the position of the "code 6" reference point, eject, punch the "code 6" and any observed data, eject and continue digitizing the trace at the "next point" after the "code 6" reference point.

8 For a "code 8" reference point step 35 is executed, then the chart is pulled along on the digitizer table and this next section of chart is re-oriented by going back to step 30.

9 After a "code 9" reference point the completed chart is removed and a new chart is started by going back to step 26 if the new chart is for the same station. But if this is a new station go to step 20.

7. CARD FORMATS

7.1 Date Card (Format 68-001)

Column(s)	Description
1-4	"DATE"
5	blank
6-16	current date, e.g. JULbb6b1976 for July 6, 1976 ("b" stands for a blank); the month is represented by its first three letters; the day and year are right justified in columns 11 and 16, respectively
17-80	blank.

This is the standard format for punching an alphanumeric date, except that the whole date will be in a different set of 11 columns on other types of cards.

7.2 Station Name Card (Format 76-002)

Column(s)	Description
1-7	station number, e.g. 05AB003
8-12	blank
13-80	station name, centred.

7.3 TGRAPH Options Card (Format 79-024)

Column(s)	Description
1-7	station number, e.g. 01ED007
8	Region code: 2 - Vancouver 4 - Winnipeg 6 - Montreal 8 - Regina 3 - Calgary 5 - Guelph 7 - Halifax
9	code for type of input chart: blank - metric input chart 1 - English input chart
10	code for type of output listing: blank - 6 months of data per page (daily minimum and maximum instantaneous water temperatures) 1 - annual page (daily mean water temperatures including monthly summary and summary for the year or standard period 2 - 4 months of data per page (daily mean, maximum and minimum water temperatures)
11-14	year for the "annual" pages
15-20	blank
21	code for type of card output: blank - no card output requested 1 - card output of daily mean water temperatures and symbols in the packed format (71-102) 2 - card output of daily water temperatures and symbols in the packed format: maximum (71-102), minimum (71-102) and mean (71-102) C - Updating corrections (79-025)
22-32	date (68-001) of the last day for which "Updating Correction" cards (79-025) are required
33	code to plot the digitized chart blank - not plotted D - plotted
34	code to plot the daily mean water temperatures blank - not plotted 1 - linear graph requested
35-80	blank.

7.4 Updating Correction Cards (Format 79-025)

Column(s)	Description
1-7	station number, e.g. 01ED007
8	blank
9-19	first date (68-001) in which the corrections on this card are to be applied
20	blank
21-25	daily maximum instantaneous water temperature in degrees Celsius. including the decimal point with one digit after the point.
26	blank
27	daily maximum instantaneous water temperature symbol
28	blank
29-33	daily minimum instantaneous water temperature, same format as the daily maximum
34	blank
35	daily minimum instantaneous water temperature symbol
36	blank
37-41	daily mean water temperature, same format as the daily maximum
42	blank
43	daily mean water temperature symbol
44-46	blank
47-48	letters "UC" for Updating Correction
49	blank
50-60	last date (68-001) on which the corrections on this card are to be applied; this date is required only if the correction(s) is applicable to more than one day
61-77	blank
78-80	card sequence number right justified; the first card in this table must be No. 1.

Cards in this table contain daily instantaneous maximum and minimum water temperatures and daily mean water temperature, along with symbols where applicable, which will override or update the results as computed by the TGRAPH program. "Updating Correction" cards (79-025) obtained as output from TGRAPH program may be used in subsequent runs as input. They must be entered in chronological order. There is no limit to the number of these cards.

Symbols that are required on output listings or output cards must be entered on "Updating Correction" cards (79-025). The symbol "E" for estimated is allowed. This symbol may be entered without a water temperature provided this value is being computed internally by the program.

If a daily mean water temperature only is entered, it will override the daily mean value as computed by the program but the computed daily maximum and minimum water temperature will remain unchanged. Similarly, if a daily maximum water temperature or minimum water temperature only is entered it will override the daily maximum or minimum as computed by the program but the computed daily mean water temperature will remain unchanged. If the daily mean, maximum and minimum water temperature as computed by the program are invalid and new values are not available, it is necessary to enter "-99.9" to override the computed results.

7.5 End of Updating Correction Table Card (Format 79-026)

Column(s)	Description
1-7	station number, e.g. 05AB003
8-46	blank
47-48	letters "UC" for updating correction
49-77	blank
78-80	"999"; this signals the end of the table.

7.6 Chart Initial Orientation Card (Format 79-027)

Column(s)	Description
1-7	station number, e.g. 05AB003
8	blank
9-19	date (68-001) of the first orientation point of the chart segment
20	blank
21	"D" or "R" indicates either direct or reverse mode at the beginning of the chart

22-26	for charts in English units:
	(a) columns 22-24 contain the vertical range of the chart in degrees Fahrenheit, right justified, e.g. 080 for a range of 80 degrees Fahrenheit or 040 for a range of 40 degrees Fahrenheit
	(b) columns 25-26 contain the time scale in tenths of inches/day, e.g. 24 for 2.4 inches/day or 96 for 9.6 inches/day
	
	Note: if columns 21-26 are left blank the program assumes the standard combination D08024, i.e. direct drive, 80 degrees Fahrenheit range and 2.4 inches/day.
	
	for charts in metric units:
	(a) columns 22-24 contain the vertical range of the chart in degrees Celsius, right justified, e.g. 045 for a range of 45 degrees Celsius or 090 for a range of 90 degrees Celsius
	(b) columns 25-26 contain the time scale in centimetres/day, e.g. 06 for 6 cm/day
	
	Note: if columns 21-26 are left blank the program assumes the standard combination D04506, i.e. direct drive, 45 degrees Celsius range and 6 cm/day.

27-73	blank
74-75	number inserted by the digitizer: this is the last two digits of the year from the fixed address switches
76	blank
77-80	card sequence number, right justified; inserted by the digitizer.

7.7 Reference Point Card (Format 79-028)

Column(s)	Description
1-7	station number, e.g. 05AB003
8	blank
9	code for the reference point: 1 - for an observed point or simply a check point 2 - 3 - for the end of a continuous record (or trace); this type of point is followed by a break in the trace 4 - 5 - 6 - for a point at which the trace has been restarted with the pen in direct drive 7 - for a point at which the trace has been restarted with the pen in reverse drive 8 - indicates that the trace is to be continued after the re-orientation which follows immediately 9 - indicates the end of the thermograph record on this chart
10-12	observed water temperatures reading in Fahrenheit or celsius without a decimal point, e.g. 320 for 32.0 degrees Fahrenheit or 000 for 00.0 degrees celsius
13-16	time of day based on the 24-hour clock, e.g. 1430 for 2:30 p.m. or 0030 for 0:30 a.m.
17-18	day of the month, e.g. 02 for the second day of the month
19-73	blank
74-75	number inserted by the digitizer; this is the last two digits of the year from the fixed address switches
76	blank
77-80	card sequence number, right justified; inserted by digitizer.

7.8 Digitizer Co-ordinate Card (Format 76-001)

Column(s)	Description
1-7	station number, e.g. 05AB003
8	blank
9-72	co-ordinates from the digitizer; up to eight sets of 4-digit (x, y) co-ordinates in tenths of millimetres
73	blank
74-75	number inserted by the digitizer; this is the last two digits of the year from the fixed address switches
76	blank
77-80	card sequence number, right justified; inserted by the digitizer.

7.9 Sequence Reset Card (Format 68-012)

Column(s)	Description
1-7	station number, e.g. 05AB003
8-75	blank
76	letter "R" for reset card

77-80	sequence number of the following card; this will save repunching cards when a sequence error is detected.

This card can be used with "Updating Correction" cards (79-025), "Reference Point" cards (79-028), or "Digitizer Co-ordinate" cards (76-011).

7.10 End of Chart...97 Card (Format 68-013)

Column(s)	Description
1-2	"97"
3-7	initials of digitizer operator or person responsible for the computations
8-80	blank.

This card is used to signify the end of a digitized chart.

7.11 End of Station...98 Card (Format 68-014)

Column(s)	Description
1-2	"98"
3-80	blank.

7.12 End of Run...99 Card (Format 68-015)

Column(s)	Description
1-2	number "99"
3-80	blank.

7.13 Updating Correction Table Program Card

Column(s)	Punches	
1	0	(zero)
2	12	(+ sign)
3-4	12-1	(letter A)
5-7	12	(+ sign)
8	11	(- sign)
9-11	1	
12	11	(- sign)
13-14	blank	
15	11	(- sign)
16-19	blank	
20	11	(- sign)
21-25	blank	
26	11	(- sign)
27	1	
28	11	(- sign)
29-33	blank	
34	11	(- sign)

35	1	
36	11	(- sign)
37-41	blank	
42	11	(- sign)
43	1	
44-46	11	(- sign)
47	0	(zero)
48	12-1	(letter A)
49	11	(- sign)
50-52	1	
53	11	(- sign)
54-55	blank	
56	11	(- sign)
57-60	blank	
61	11	(- sign)
62-77	12	(+ sign)
78-80	blank.	

7.14 Digitizer Program Card

Column(s)	Punches	
1	0	(zero)
2	12	(+ sign)
3-4	12-1	(letter A)
5-7	12	(+ sign)
8	11	(- sign)
9	1	
10-11	12-1	(letter A)
12-20	12	(+ sign)
21	12-1	(letter A)
22-71	12	(+ sign)
72	12-1-2	
73-80	blank.	

7.15 Use of Program Cards

In the drum cards the punches 12, 11, 0 and 1 control the following four standard functions:

(a) 12 punch (+) for field definition; that is, continuation of a skip or a duplicate, e.g. 0++++ in columns 1 to 5 will signal to the keypunch that duplication is defined up to column 5;
(b) 11 punch (-) to initiate automatic skipping, e.g. -++++ in columns 1 to 5 will signal to the keypunch that the skip field is defined up to column 5;
(c) 0 punch to initiate automatic duplicating, e.g. 0+-++ in columns 1 to 5 will permit duplication of columns 1 and 2 and skipping of columns 3 to 5; and
(d) 1 punch for the alphabetic shift, e.g. 11-++ in columns 1 to 5 will permit alphabetic characters in columns 1 and 2 without having to hold the alpha shift key and columns 3 to 5 will be skipped.

8. TGRAPH PROGRAM

The TGRAPH computer program is used to obtain daily mean water temperature and instantaneous daily maximum and minimum water temperatures. Thermograph charts are processed using a Gradicon digitizer to obtain punched cards containing the X-Y coordinates. These X-Y co-ordinates are combined with updating corrections cards and then submitted for computer processing. The program will process any number of stations in a single computer run. The data for one run could include several years of record.

8.1 Preparing Data for Computer Run

8.1.1 TGRAPH Deck Set-up.

Figure 14 shows that the input cards should be arranged as follows:

(a) "Station Name" card (76-002)

This card follows either the "Date" card (68-001) or an "End of Station ...98" card (68-014). The station number and name on this card are assumed to be correct. If the station number is in fact wrong then the program will assume that all remaining cards with a different station number are incorrect. The program assumes that this card is followed by the "TGRAPH Options" card (77-024).

(b) "TGRAPH Options" Card (79-024)

(c) Updating Correction Table

If there are updating corrections, the first "Updating Correction" card (79-025) always follows the "TGRAPH Options" card (79-024). The program will continue to read cards and expect them to be "Updating Correction" cards (79-025) until an "End of Updating Correction Table" card (79-026) is detected. If this card is missing all the cards that follow will be read and interpreted as "Updating Correction" cards.

The "End of Updating Correction Table" card (79-026) follows either the last "Updating Correction" card, when there are updating corrections to be applied, or the "TGRAPH Options" card, when there are no updating corrections.

(d) Chart Decks

The above mentioned table is followed by any number of chart segment decks. The chart decks are arranged in chronological order, e.g. the deck for the chart from April 24 to May 10, 1977 is followed by the deck for the chart from May 10 to June 22 1977. The first card of each chart deck is always the "Chart Initial Orientation" card (79-027). It is followed by a number of "Digitizer Co-ordinate" cards (76-011), "Reference Point" cards (79-028) and possibly "Sequence Reset" cards (68-012). All the above mentioned cards are followed by an "End of Chart...97" card (68-013).

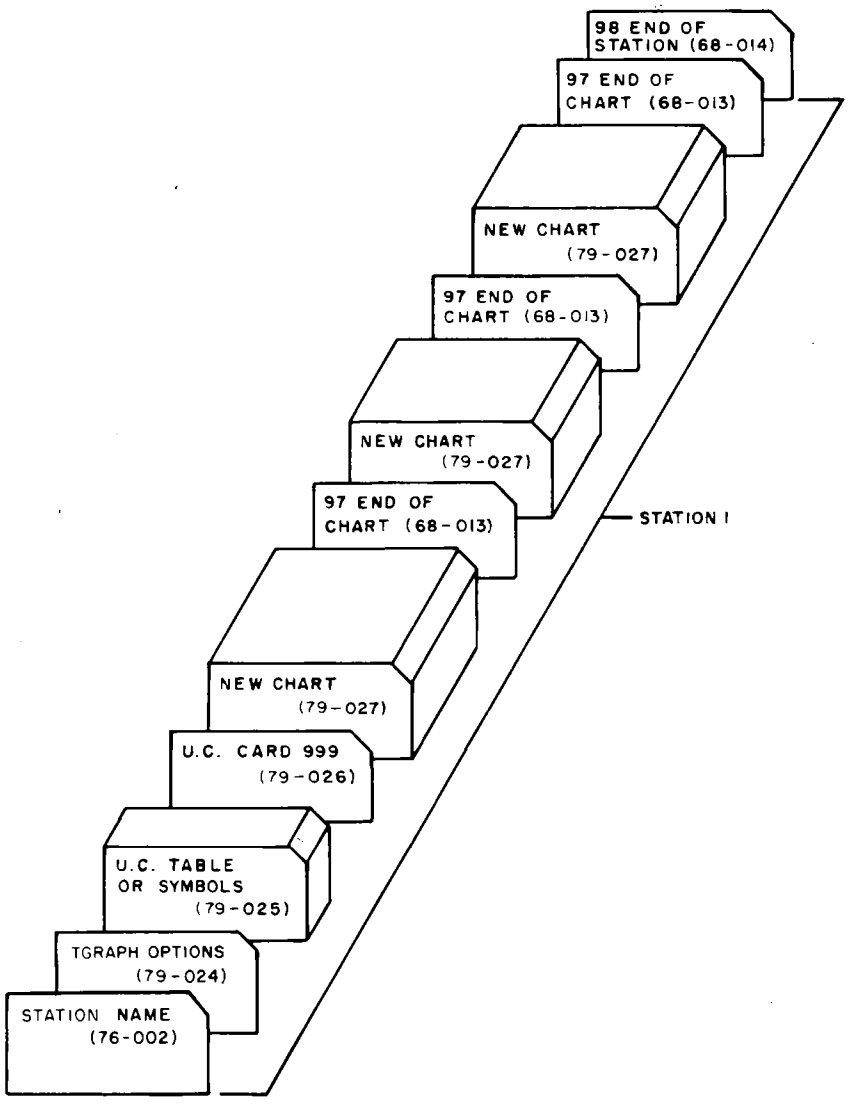

98 END OF STATION (68-014)
97 END OF CHART (68-013)
NEW CHART (79-027)
97 END OF CHART (68-013)
NEW CHART (79-027)
97 END OF CHART (68-013)
STATION I
NEW CHART (79-027)
U.C. CARD 999 (79-026)
U.C. TABLE OR SYMBOLS (79-025)
TGRAPH OPTIONS (79-024)
STATION NAME (76-002)

FIGURE 14

The "Chart Initial Orientation" card (79-027) follows either an "End of Updating Correction Table" card (79-026) or an "End of Chart...97" card (68-013). The program assumes that it is always followed by a "Digitizer Co-ordinate" card (76-011) containing at least 7 sets of x-y co-ordinates: one for each of the 6 orientation points and a seventh set for the first point read after the orientation. If the eighth set of x-y co-ordinates is absent, i.e. x and y are both blank, then the program assumes that the seventh set of x-y co-ordinates belongs to a reference point and that a "Reference Point" card (79-028) follows immediately. If the eighth set of x-y co-ordinates is present it assumes that the seventh and eighth sets of x-y co-ordinates belong to the first and second points digitized after the orientation and that the next card is another "Digitizer Co-ordinate" card (76-011). When the operator comes to a reference point, he first digitizes the point then ejects the card before entering the code and observed readings (if any) on the next card which is the "Reference Point" card (79-028) for that point. Ejecting the card before entering data through the auxiliary keyboard causes the last "Digitizer Co-ordinate" card (76-011) to have missing x-y co-ordinates. It is possible for that last card to contain no co-ordinates at all. This will be the case whenever the co-ordinates for the reference point happen to be the eighth set on a card. After the co-ordinates have been punched, the card punch will feed another card and stop. When the operator ejects the card it will be released without co-ordinates.

A "Reference Point" card (79-028) always follows a "Digitizer Co-ordinate" card (76-011) that does not contain 8 sets of x-y co-ordinates. If the reference point has a code of "9" the next card is assumed to be an "End of Chart...97" card (68-013). If the reference point has a code of "8" the following "Digitizer Co-ordinate" card is assumed to contain 8 sets of x-y co-ordinates, one for each of the 6 orientation points, a seventh for the location of the code "8" reference point, and the eighth for a point further along the curve.

A "Sequence Reset" card (68-012) does not influence the control of the program. It simply resets the card count and goes back to reading the same type of card it was expecting when the "Sequence Reset" card was read.

The "End of Chart...97" card (68-013) always follows a "Reference Point" card with a code of "9" and it is followed either by a "Chart Initial Orientation" card, by an "End of Station...98" card or by an "End of Run...99" card.

The "End of Station...98" card (68-014) is always followed by the "Station Name" card for the next station to be processed.

The "End of Run...99" card (68-015) appears only once and is always the last card of the input data deck to the TGRAPH program.

DECK SET-UP FOR A COMPUTER RUN

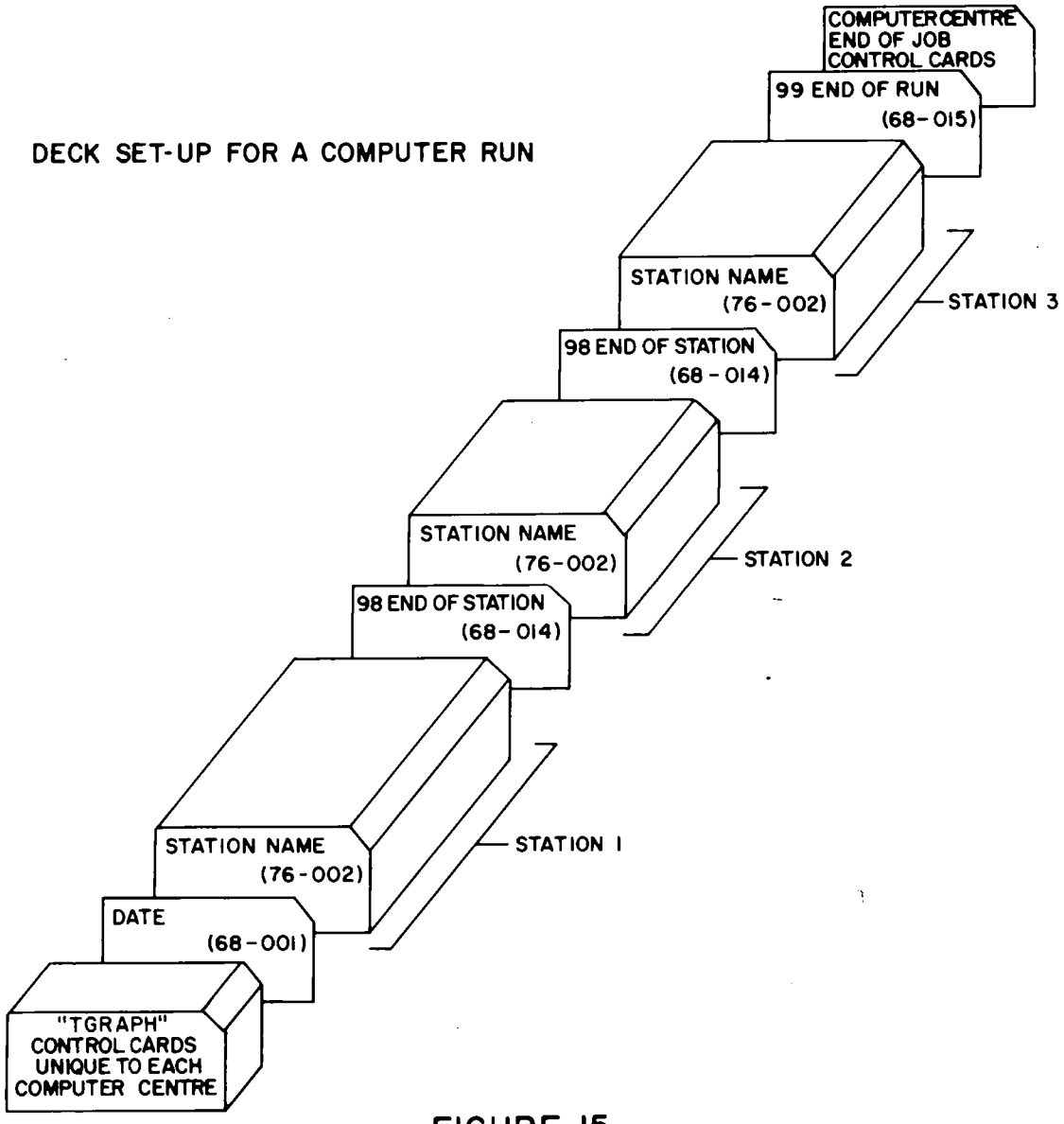


FIGURE 15

Figure 15 shows the complete deck set-up for a TGRAPH computer run. The cards must be in the following order:

(a) Program Control Cards

The program control cards are unique to each computer centre. They retrieve the TGRAPH program from disk or drum storage and give control to the TGRAPH program which will read the following data cards.

(b) Date Card (68-001)

This card contains the current date and is used to date the listings. It should be punched just before the data are sent for a computer run.

(c) Station Decks

The "Date" card (68-001) is followed by a number of station decks. Each of these decks are arranged as shown in Figure 14. Every station deck except the last station deck of the run is followed by an "End of Station...98" card (68-014). This card indicates to the program that this is the end of the station deck just read and that another station deck follows.

(d) End of Run...99 Card (68-015)

This card indicates the end of the last station deck and no more data is to follow. The last station deck is followed by this card.

(e) End of Job Control Cards

Computer centre end of job control card(s) indicate that the TGRAPH Program is no longer required and that the job is complete.

8.2 TGRAPH Output Listings

This section of the manual describes the information that is produced on output as a result of processing thermograph stations.

The basic output listings from the TGRAPH program are the "six months per page" report, the "four months per page" report and the "annual" report, these reports cannot be produced together from the same "TGRAPH" option card (79-024).

Every page of output is printed with the standard page heading which contains the Division name (Water Survey of Canada), current date, page number, location of the District office, the station name and the station number. The current date is obtained from the "Date" card (68-001) and the station name and the station number are obtained from the "Station Name" card (76-002).

8.2.1 Options

The TGRAPH program options that are coded on the "TGRAPH Options" card (79-024) are printed on the output listing. The heading, "column(s)", indicates the card column on the "TGRAPH Options" card (79-024) where the option is coded. The heading, "code", is the value that is entered on the card and the heading, "option requested", defines the option code requested.

WATER SURVEY OF CANADA MERSEY RIVER BELOW MILL FALLS (STATION NO 4) STATION NO. 01ED007
AUG 20 1979 PAGE 14
HALIFAX, N.S.

TGRAPH PROGRAM OPTIONS

COLUMN(S)	CODE	OPTION REQUESTED
8	7	HALIFAX, N.S.
9	1	ENGLISH CHART
10		6 MONTHS OF DATA PER PAGE
21	2	DAILY MEAN AND INSTANTANEOUS WATER TEMPERATURE CARD OUTPUT
34	1	DAILY MEAN WATER TEMPERATURES PLOTTED

UPDATING CORRECTIONS TO THE WATER TEMPERATURES

FIRST DAY	MAXIMUM (CELSIUS)	SYMBOL	MINIMUM (CELSIUS)	SYMBOL	MEAN (CELSIUS)	SYMBOL	UC	LAST DAY	CARD NO.
NONE									

8.2.2 Updating Correction Table

One line is printed for each "Updating Correction" card (79-025) showing the first day of the correction and/or the symbol for the maximum, the minimum and the mean water temperatures, the last day of the correction and the card number. The "End of Updating Correction Table" card (79-026) causes the message "END OF TABLE" to be printed.

If there are no updating corrections and thus only the "End of Updating Correction Table" card is present, then the message "NONE" is printed.

WATER SURVEY OF CANADA MERSEY RIVER BELOW MILL FALLS (STATION NO 1) STATION NO. 01ED007
AUG 20 1979 PAGE 1
HALIFAX, N.S.

TGRAPH PROGRAM OPTIONS

COLUMN(S)	CODE	OPTION REQUESTED
8	7	HALIFAX, N.S.
9	1	ENGLISH CHART
11-14		ANNUAL PAGE PRINTED FOR 1977
34	1	DAILY MEAN WATER TEMPERATURES PLOTTED

UPDATING CORRECTIONS TO THE WATER TEMPERATURES

FIRST DAY	MAXIMUM (CELSIUS)	SYMBOL	MINIMUM (CELSIUS)	SYMBOL	MEAN (CELSIUS)	SYMBOL	UC	LAST DAY	CARD NO.
JAN 2 1977	0.0	E	0.0	E	0.0	E		JAN 3 1977	1
MAY 20 1977	10.1	E	9.0	E	+9.5			MAY 21 1977	2
JUN 1 1977	+15.0	E							3
JUN 2 1977			14.0	E					4
JUN 3 1977					+20.5	E			5
JUN 10 1977	10.5	E	-99.9		-99.9	E			6
END OF TABLE									

8.2.3 Reference Point Summary

In this part of the listing the program prints any errors in the orientations and the reference points in the order in which they appear in the input deck for each chart.

The information in the Reference Point Summary is given in the following order from left to right:

Card No.	- the sequence card number with the reference point information.
Recorder Drive	- "D" for direct.
Code	- the single digit reference point code that was keypunched on the auxiliary keyboard during the digitizing.
Observed Readings	_ the date, time of day and temperature value keypunched on the "Reference Point" card during the digitizing.
Chart Readings	- the date, time of day and temperature value as computed by the TGRAPH program from the digitizer co-ordinates.
Chart Corrections	- the time and paper corrections as computed by the program. These are only printed for a check point; that is, a reference point with observed data.
Inches/Metres from Bottom of Chart	- this is the position of the reference point from the base line of the chart. This value is useful in locating the exact point where the operator read the reference point when the chart was digitized.

WATER SURVEY OF CANADA
AUG 20 1979 PAGE 6
HALIFAX, N.S.

MERSEY RIVER BELOW MILL FALLS (STATION NO 2)

STATION NO. 01ED007

REFERENCE POINT SUMMARY

CARD NO.	DRIVE	CODE	OBSERVED READINGS DATE	OBSERVED READINGS TIME	OBSERVED READINGS FAHRENHEIT	CHART READINGS DATE	CHART READINGS TIME	CHART READINGS FAHRENHEIT	CHART CORR. HRS	CHART CORR. FAHRENHEIT	INCHES FROM BOTTOM OF CHART
2	NEW CHART		JAN 1 1977	MAX. ERROR = .012 IN. DRIVE = D	RANGE = 80.0	DEGREES FAHRENHEIT					2.4 IN./DAY
3	D	1	JAN 1 1977	0- 0	32.0	JAN 1 1977	0-11	32.0	-.18	.0	.107
	SEQ. RESET		*** CARD NO. 3 TO FOLLOW CARD NO. 3 ***								
10	D	1	JAN 8 1977	9-15	32.0	JAN 8 1977	9-23	32.2	-.13	-.2	.116
13	D	8				JAN 12 1977	0- 1	31.7			.094
14	RE-ORIENT.		JAN 12 1977	MAX. ERROR = .005 IN.							
14	D		THIS IS THE NEXT READING			JAN 12 1977	0- 5	31.7			.091
31	D	1	JAN 21 1977	13-15	34.0	JAN 21 1977	13-12	32.0	.05	2.0	.109
33	D	6	JAN 21 1977	13-15	34.0	JAN 21 1977	13-14	34.0	.01	0.0	.081
38	D	9	JAN 26 1977	14-40	32.0	JAN 26 1977	14-41	34.2	-.02	-2.2	.089
		97	DIGITIZED BY GALA								
2	NEW CHART		JAN 26 1977	MAX. ERROR = .004 IN. DRIVE = D	RANGE = 80.0	DEGREES FAHRENHEIT					2.4 IN./DAY
3	D	1	JAN 26 1977	14-45	32.0	JAN 26 1977	14-44	32.0	.01	.0	.100
9	D	1	FEB 4 1977	12-35	32.0	FEB 4 1977	12-51	32.4	-.26	-.4	.118
13	D	8				FEB 9 1977	0- 0	32.4			.118
14	RE-ORIENT.		FEB 9 1977	MAX. ERROR = .007 IN.							
14	D		THIS IS THE NEXT READING			FEB 9 1977	0- 0	32.3			.116
21	D	1	FEB 11 1977	13- 1	33.0	FEB 11 1977	13-17	32.5	-.27	.5	.123
23	D	6	FEB 11 1977	13- 1	33.0	FEB 11 1977	13-24	33.0	-.39	0.0	.108
29	D	1	FEB 18 1977	13-55	33.0	FEB 18 1977	13-15	32.8	.66	.2	.096
34	D	8				FEB 22 1977	23-52	32.9			.104
35	RE-ORIENT.		FEB 23 1977	MAX. ERROR = .009 IN.							
35	D		THIS IS THE NEXT READING			FEB 23 1977	0- 1	33.0			.107
39	D	1	FEB 26 1977	8-45	32.0	FEB 26 1977	9-13	33.0	-.46	-1.0	.109
46	D	8				MAR 8 1977	23-58	32.6			.090
47	RE-ORIENT.		MAR 9 1977	MAX. ERROR = .003 IN.							
47	D		THIS IS THE NEXT READING			MAR 9 1977	0- 6	32.6			.085
50	D	1	MAR 10 1977	15-30	32.0	MAR 10 1977	16-15	32.5	-.75	-.5	.085
59	D	1	MAR 18 1977	9-30	33.0	MAR 18 1977	10-43	33.8	-1.22	-.8	.148
70	D	8				MAR 22 1977	23-55	35.7			.243
71	RE-ORIENT.		MAR 23 1977	MAX. ERROR = .004 IN.							

The first line for each chart print out is for the chart initial orientation. It contains the message "NEW CHART". On this line is printed the sequence number of the card containing the six orientation co-ordinates; i.e. the "Digitizer Co-ordinate" card (76-011) that immediately follows the "Chart Initial Orientation" card (79-027). This line also contains the date for the first orientation point that was digitized, the maximum orientation error, the recorder drive (D), the chart range and the time scale. Except for the maximum error, which is computed by the program, the information printed on this line comes from the "Chart Initial Orientation" card (79-027). An example of this message is as follows:

ENGLISH CHART

```
2  NEW CHART   *  JAN  1 1977   MAX. ERROR =  .012 IN. DRIVE = D   RANGE =   80.0 DEGREES FAHRENHEIT *      2.4 IN./DAY
```

METRIC CHART

```
2  NEW CHART   *  JAN  1 1979   MAX. ERROR =  .0002 M  DRIVE = D   RANGE =   45.0 DEGREES CELSIUS    *      6.0 CM/DAY
```

The reference points are printed in the order in which they appear in the input deck. If the point in question is a check point, that is, it has observed readings, then a line similar to the following will appear.

```
3     D     1  *  JAN  1 1979  0- 0     0.0    *  DEC 31 1978 23-58     -.0   *     .03       .0   *         .000
```

If the point in question is not a check point, then no chart corrections can be computed and printed within the line:

```
6     D     8  *                                *  JAN 13 1979 23-57     40.1  *                  *         .080
```

If the point in question is not a reference point then the message "THIS IS THE NEXT READING" appears where the observed readings are normally printed:

ENGLISH CHART

```
14  RE-ORIENT.   *  JAN 12 1977   MAX. ERROR =  .005 IN.                                          *
14     D         *   THIS IS THE NEXT READING    *  JAN 12 1977  0- 5     31.7  *                  *         .091
```

METRIC CHART

```
9   RE-ORIENT.   *  JAN 14 1979   MAX. ERROR =  .0002 M                                          *
9      D         *   THIS IS THE NEXT READING    *  JAN 14 1979  0- 4     39.9  *                  *         .080
```

After a reference point with a code of "8" the results of the new orientation are printed along with the message "RE-ORIENT". The card sequence number printed is that of the co-ordinate card containing the 6 orientation points and the date is that of the first orientation point, i.e. the zero hour of the day where the "code 8" point is located on the chart.

The "End of Chart...97" card (68-013) causes the code "97" to be printed along with the message "DIGITIZED BY" followed by the initials which are taken from columns 3 to 7 of the "End of Chart...97" card (68-013).

The "End of Station...98" card (68-014) causes the code "98" to be printed. The "End of Run...99" card (68-015) causes the code "99" to be printed.

The program works out temperatures by making the chart reading of the first check point after the chart initial orientation (or after a code 6 reference point) equal to the observed temperature reading from the first check point encountered. All points that are printed before the first check point have -99.9 under the Fahrenheit for the chart readings. This does not necessarily indicate an error. At the time the point in question is printed the value of the chart reading is not yet available to the program. When the first check point is reached the program will back-track and compute any points that have already been read. These points will then be included with other data to produce the daily figures.

8.2.4 Six Months of Daily Maximum and Minimum Water Temperatures per Page

The 6 month/page output is obtained by leaving a blank in column 10 of the "TGRAPH Options" card (79-024). All temperature values are in Celsius.

The daily data consists of daily maximum and minimum water temperatures and their symbols. The temperatures are rounded and printed to one decimal after the point. When a day is not applicable for a particular month, e.g. day 31 for June, the program prints "-11.1" instead of a legitimate value. When the necessary data are not available in the input deck or data has been deleted after errors are detected the program prints "-99.9" for a missing figure.

For each month the program prints the non-rounded monthly total, maximum and minimum and the rounded monthly mean. If a month is incomplete, the program prints "-99.9" in the summary for this month.

WATER SURVEY OF CANADA
OCT 04 1979 PAGE 8
HALIFAX, N.S.

MERSEY RIVER BELOW MILL FALLS (STATION NO 2)

STATION NO. 01ED007

(PRELIMINARY) DAILY WATER TEMPERATURES IN DEGREES CELSIUS

DAY	JAN 1977 MAX.	JAN 1977 MIN.	DAY	FEB 1977 MAX.	FEB 1977 MIN.	DAY	MAR 1977 MAX.	MAR 1977 MIN.	DAY	APR 1977 MAX.	APR 1977 MIN.	DAY	MAY 1977 MAX.	MAY 1977 MIN.	DAY	JUN 1977 MAX.	JUN 1977 MIN.
1	0.1	0.0	1	-0.1	-0.1	1	0.0	-0.1	1	2.4	1.3	1	11.6	8.9	1	15.0 E	-99.9
2	0.0 E	0.0 E	2	0.0	-0.1	2	0.0	0.0	2	2.2	0.8	2	11.2	9.4	2	-99.9	14.0 E
3	0.0 E	0.0 E	3	0.0	-0.1	3	0.1	0.0	3	1.8	1.3	3	11.4	10.1	3	-99.9	-99.9
4	0.1	-0.1	4	0.0	-0.1	4	0.0	0.0	4	1.7	0.5	4	11.0	9.1	4	-99.9	-99.9
5	0.0	-0.1	5	0.1	-0.1	5	0.1	0.0	5	1.4	1.0	5	11.7	9.0	5	-99.9	-99.9
6	0.0	-0.1	6	0.1	0.1	6	0.0	0.0	6	2.6	1.2	6	11.5	9.9	6	-99.9	-99.9
7	0.1	0.0	7	0.2	0.1	7	0.0	-0.1	7	2.3	1.6	7	10.7	10.0	7	-99.9	-99.9
8	0.0	-0.2	8	0.3	0.2	8	0.0	-0.1	8	1.6	1.0	8	10.7	9.1	8	-99.9	-99.9
9	0.0	-0.1	9	0.7	0.3	9	0.0	-0.1	9	1.0	0.8	9	10.8	9.0	9	-99.9	-99.9
10	0.0	0.0	10	0.4	0.3	10	0.0	0.0	10	1.4	0.5	10	10.7	7.8	10	10.5 E	-99.9
11	0.1	0.0	11	0.6	0.3	11	0.0	-0.1	11	2.4	0.9	11	8.0	7.4	11	-99.9	-99.9
12	0.4	0.0	12	0.5	0.4	12	0.0	-0.1	12	3.4	1.9	12	10.4	7.4	12	-99.9	-99.9
13	0.7	0.3	13	0.5	0.5	13	0.5	0.0	13	4.2	2.6	13	10.4	9.4	13	-99.9	-99.9
14	1.2	0.7	14	0.5	0.4	14	0.6	0.4	14	4.4	3.9	14	9.4	8.1	14	-99.9	-99.9
15	1.0	0.6	15	0.6	0.5	15	0.8	0.5	15	4.5	3.4	15	8.8	7.9	15	-99.9	-99.9
16	1.2	0.7	16	0.6	0.6	16	1.0	0.8	16	5.2	3.5	16	8.8	8.3	16	-99.9	-99.9
17	0.8	0.7	17	0.6	0.5	17	1.0	0.8	17	5.9	4.1	17	-99.9	-99.9	17	-99.9	-99.9
18	0.9	0.8	18	0.6	0.5	18	0.8	0.5	18	6.7	4.8	18	-99.9	-99.9	18	-99.9	-99.9
19	1.1	0.9	19	0.6	0.5	19	0.6	0.2	19	7.2	5.3	19	-99.9	-99.9	19	-99.9	-99.9
20	1.4	1.0	20	0.5	0.4	20	0.9	0.2	20	7.7	5.6	20	10.1 E	9.0 E	20	-99.9	-99.9
21	1.2	1.0	21	0.4	0.3	21	1.5	0.6	21	8.9	6.4	21	10.1 E	9.0 E	21	-99.9	-99.9
22	1.0	0.9	22	0.3	0.2	22	2.0	0.9	22	10.0	8.1	22	-99.9	-99.9	22	-99.9	-99.9
23	0.9	0.6	23	0.3	0.1	23	1.6	0.7	23	9.9	9.4	23	-99.9	-99.9	23	-99.9	-99.9
24	0.6	0.5	24	0.2	0.1	24	0.8	0.7	24	9.4	8.2	24	-99.9	-99.9	24	-99.9	-99.9
25	0.5	0.2	25	0.1	0.0	25	1.5	0.7	25	8.2	7.7	25	-99.9	-99.9	25	-99.9	-99.9
26	0.2	0.0	26	0.0	0.0	26	1.7	1.2	26	8.2	7.8	26	-99.9	-99.9	26	-99.9	-99.9
27	0.0	0.0	27	0.0	-0.1	27	2.8	1.3	27	9.7	8.1	27	-99.9	-99.9	27	-99.9	-99.9
28	0.0	-0.1	28	0.0	-0.1	28	3.8	1.6	28	10.3	9.2	28	-99.9	-99.9	28	-99.9	-99.9
29	-0.1	-0.1	29	-11.1	-11.1	29	3.2	2.2	29	10.9	9.4	29	-99.9	-99.9	29	-99.9	-99.9
30	-0.1	-0.2	30	-11.1	-11.1	30	3.7	2.1	30	10.8	9.5	30	-99.9	-99.9	30	-99.9	-99.9
31	-0.1	-0.2	31	-11.1	-11.1	31	3.2	2.4	31	-11.1	-11.1	31	-99.9	-99.9	31	-11.1	-11.1
TOT.	13.2	7.7		8.6	5.6		32.2	17.2		166.3	129.8		-99.9	-99.9		-99.9	-99.9
MEAN	0.4	0.2		0.3	0.2		1.0	0.6		5.5	4.3		-99.9	-99.9		-99.9	-99.9
MAX	1.4	1.0		0.7	0.6		3.8	2.4		10.9	9.5		-99.9	-99.9		-99.9	-99.9
MIN	-0.1	-0.2		-0.1	-0.1		0.0	-0.1		1.0	0.5		-99.9	-99.9		-99.9	-99.9

NOTE THAT -11.1 = NOT APPLICABLE AND -99.9 = MISSING DATA

8.2.5 Four Months of Daily Maximum, Minimum and Mean Water Temperatures per Page

The 4 month/page output is obtained by coding a "2" in column 10 of the "TGRAPH Options" card (79-024). All temperature values are in Celsius.

The daily data consists of daily maximum, minimum and mean water temperatures and their symbols. The temperatures are rounded and printed to one decimal after the point. When a day is not applicable for a particular month, e.g. day 31 for JUNE, the program prints "-11.1" instead of a legitimate value. When the necessary data are not available in the input deck or data has been deleted after errors are detected the program prints "-99.9" for a missing figure.

For each month the program prints the non-rounded monthly total, maximum and minimum and the rounded monthly mean. If a month is incomplete, the program prints "-99.9" in the summary for this month.

WATER SURVEY OF CANADA
OCT 04 1979 PAGE 12
HALIFAX, N.S.

MERSEY RIVER BELOW MILL FALLS (STATION NO 3)

STATION NO. 01ED007

(PRELIMINARY) DAILY WATER TEMPERATURES IN DEGREES CELSIUS

	JAN 1977				FEB 1977				MAR 1977				APR 1977			
	DAY	MAX.	MIN.	MEAN	DAY	MAX.	MIN.	MEAN	DAY	MAX.	MIN.	MEAN	DAY	MAX.	MIN.	MEAN
	1	0.1	0.0	0.0	1	-0.1	-0.1	-0.1	1	0.0	-0.1	0.0	1	2.4	1.3	1.8
	2	0.0 E	0.0 E	0.0 E	2	0.0	-0.1	0.0	2	0.0	0.0	0.0	2	2.2	0.8	1.5
	3	0.0 E	0.0 E	0.0 E	3	0.0	-0.1	0.0	3	0.1	0.0	0.0	3	1.8	1.3	1.5
	4	0.1	-0.1	0.0	4	0.0	-0.1	-0.1	4	0.0	0.0	0.0	4	1.7	0.5	1.1
	5	0.0	-0.1	0.0	5	0.1	-0.1	0.0	5	0.1	0.0	0.0	5	1.4	1.0	1.2
	6	0.0	-0.1	-0.1	6	0.1	0.1	0.1	6	0.0	0.0	0.0	6	2.6	1.2	1.9
	7	0.1	0.0	0.0	7	0.2	0.1	0.2	7	0.0	-0.1	0.0	7	2.3	1.6	1.9
	8	0.0	-0.2	-0.1	8	0.3	0.2	0.3	8	0.0	-0.1	0.0	8	1.6	1.0	1.2
	9	0.0	-0.1	-0.1	9	0.7	0.3	0.5	9	0.0	-0.1	0.0	9	1.0	0.8	0.9
	10	0.0	0.0	0.0	10	0.4	0.3	0.4	10	0.0	0.0	0.0	10	1.4	0.5	0.9
	11	0.1	0.0	0.0	11	0.6	0.3	0.5	11	0.0	-0.1	-0.1	11	2.4	0.9	1.6
	12	0.4	0.0	0.3	12	0.5	0.4	0.5	12	0.0	-0.1	0.0	12	3.4	1.9	2.5
	13	0.7	0.3	0.5	13	0.5	0.5	0.5	13	0.5	0.0	0.2	13	4.2	2.6	3.4
	14	1.2	0.7	0.9	14	0.5	0.4	0.5	14	0.6	0.4	0.5	14	4.4	3.9	4.1
	15	1.0	0.6	0.8	15	0.6	0.5	0.6	15	0.8	0.5	0.7	15	4.5	3.4	3.9
	16	1.2	0.7	0.9	16	0.6	0.6	0.6	16	1.0	0.8	0.8	16	5.2	3.5	4.3
	17	0.8	0.7	0.7	17	0.6	0.5	0.5	17	1.0	0.8	0.9	17	5.9	4.1	4.9
	18	0.9	0.8	0.8	18	0.6	0.5	0.5	18	0.8	0.5	0.7	18	6.7	4.8	5.7
	19	1.1	0.9	1.0	19	0.6	0.5	0.5	19	0.6	0.2	0.3	19	7.2	5.3	6.2
	20	1.4	1.0	1.2	20	0.5	0.4	0.5	20	0.9	0.2	0.5	20	7.7	5.6	6.6
	21	1.2	1.0	1.1	21	0.4	0.3	0.3	21	1.5	0.6	1.0	21	8.9	6.4	7.6
	22	1.0	0.9	1.0	22	0.3	0.2	0.3	22	2.0	0.9	1.3	22	10.0	8.1	8.9
	23	0.9	0.6	0.8	23	0.3	0.1	0.2	23	1.6	0.7	1.0	23	9.9	9.4	9.6
	24	0.6	0.5	0.5	24	0.2	0.1	0.1	24	0.8	0.7	0.8	24	9.4	8.2	8.9
	25	0.5	0.2	0.3	25	0.1	0.0	0.0	25	1.5	0.7	1.0	25	8.2	7.7	7.9
	26	0.2	0.0	0.1	26	0.0	0.0	0.0	26	1.7	1.2	1.4	26	8.2	7.8	8.0
	27	0.0	0.0	0.0	27	0.0	-0.1	0.0	27	2.8	1.3	2.0	27	9.7	8.1	8.8
	28	0.0	-0.1	-0.1	28	0.0	-0.1	-0.1	28	3.8	1.6	2.6	28	10.3	9.2	9.6
	29	-0.1	-0.1	-0.1	29	-11.1	-11.1	-11.1	29	3.2	2.2	2.4	29	10.9	9.4	10.1
	30	-0.1	-0.2	-0.1	30	-11.1	-11.1	-11.1	30	3.7	2.1	2.8	30	10.8	9.5	10.1
	31	-0.1	-0.2	-0.1	31	-11.1	-11.1	-11.1	31	3.2	2.4	2.6	31	-11.1	-11.1	-11.1
TOT.		13.2	7.7	10.2		8.6	5.6	7.3		32.2	17.2	23.4		166.3	129.8	146.6
MEAN		0.4	0.2	0.3		0.3	0.2	0.3		1.0	0.6	0.8		5.5	4.3	4.9
MAX		1.4	1.0	1.2		0.7	0.6	0.6		3.8	2.4	2.8		10.9	9.5	10.1
MIN		-0.1	-0.2	-0.1		-0.1	-0.1	-0.1		0.0	-0.1	-0.1		1.0	0.5	0.9

NOTE THAT -11.1 = NOT APPLICABLE AND -99.9 = MISSING DATA

8.2.6 Annual Page of Daily Water Temperature

The Annual page report is obtained by coding a "1" in column 10 of the "TGRAPH Options" card (79-024).

The annual page contains all of the daily mean water temperatures for up to one year together with the appropriate symbols. The required year is read from the "TGRAPH Options" card (79-024).

The non-rounded monthly total, the rounded monthly mean, the maximum rounded daily mean water temperature and the minimum rounded daily mean water temperature are printed for complete months. All temperature values are rounded and printed to one decimal after the point. The only symbol allowed is an E.

If there is data for all days in the year then the summary report is printed. The summary for the year contains the rounded mean water temperature, the maximum and the minimum daily mean water temperatures and their dates of first occurrence.

WATER SURVEY OF CANADA
OCT 04 1979 PAGE 36
HALIFAX, N.S.

MERSEY RIVER BELOW MILL FALLS (STATION NO 8)

STATION NO. 01ED007

(PRELIMINARY) DAILY MEAN WATER TEMPERATURE IN DEGREES CELSIUS FOR 1977

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	0.0	-0.1	0.0	1.8	10.0	16.1	19.7	20.3	20.8	12.7	7.1	2.8	1
2	0.0 E	0.0	0.0	1.5	10.3	16.8	20.4	21.3	21.0	12.8	7.4	3.0	2
3	0.0 E	0.0	0.0	1.5	10.7	20.5 E	20.7	22.0	21.6	13.4	7.4	3.0	3
4	0.0	-0.1	0.0	1.1	10.1	14.2	20.4	23.0	20.9	13.5	7.7	2.6	4
5	0.0	0.0	0.0	1.2	10.3	13.7	20.5	23.5	19.7	13.0	9.0	1.9	5
6	-0.1	0.1	0.0	1.9	10.5	12.6	19.5	23.5	19.5	12.8	8.1	0.8	6
7	0.0	0.2	0.0	1.9	10.2	11.7	19.1	23.5	19.1	12.9	8.2	0.9	7
8	-0.1	0.3	0.0	1.2	9.9	11.3	20.1	23.7	18.2	12.4	7.1	0.0 E	8
9	-0.1	0.5	0.0	0.9	9.9	11.9	20.6	24.0	17.4	12.0	7.3	0.0 E	9
10	0.0	0.4	0.0	0.9	8.8	12.2 E	20.3	22.7	17.4	12.4	8.5	0.0 E	10
11	0.0	0.5	-0.1	1.6	7.7	12.0	20.8	21.8	17.9	12.4	9.1	0.0 E	11
12	0.3	0.5	0.0	2.5	8.6	12.6	21.0	20.7	17.0	11.8	8.5	0.0 E	12
13	0.5	0.5	0.2	3.4	9.7	12.9	20.6	21.2	15.8	11.7	8.4	0.0 E	13
14	0.9	0.5	0.5	4.1	8.5	13.6	19.1	21.4	15.3	11.0	8.1	0.0 E	14
15	0.8	0.6	0.7	3.9	8.3	14.1	20.7	21.6	14.8	10.7	6.9	0.0 E	15
16	0.9	0.6	0.8	4.3	8.5	14.9	21.8	20.7	14.2	10.9	6.7	0.0 E	16
17	0.7	0.5	0.9	4.9	9.6	15.2	22.9	20.2	14.8	11.2	7.1	0.0 E	17
18	0.8	0.5	0.7	5.7	12.3	14.5	23.8	20.3	15.4	11.0	8.3	0.0 E	18
19	1.0	0.5	0.3	6.2	12.4	13.4	24.0	20.1	16.0	10.5	7.6	0.0 E	19
20	1.2	0.5	0.5	6.6	9.5	13.3	24.8	19.7	15.7	10.5	6.6	0.0 E	20
21	1.1	0.3	1.0	7.6	9.5	13.2	25.9	19.6	14.7	10.5	6.3	0.0 E	21
22	1.0	0.3	1.3	8.9	15.1	12.6	25.4	19.3	14.1	9.9	6.6	0.0 E	22
23	0.8	0.2	1.0	9.6	17.0	12.7	22.9	19.6	14.0	9.2	6.4	0.0 E	23
24	0.5	0.1	0.8	8.9	18.4	13.8	22.1	19.9	13.7	8.3	6.1	0.0 E	24
25	0.3	0.0	1.0	7.9	19.1	14.4	21.7	19.8	13.4	8.2	6.1	0.0 E	25
26	0.1	0.0	1.4	8.0	17.7	14.8	20.9	19.1	13.5	8.4	6.0	0.0 E	26
27	0.0	0.0	2.0	8.8	15.1	15.6	20.1	18.7	14.7	9.6	5.5	0.0 E	27
28	-0.1	-0.1	2.6	9.6	13.5	16.9	20.1	19.8	15.1	9.9	4.2	0.0 E	28
29	-0.1		2.4	10.1	12.8	19.0	20.3	21.5	14.9	9.1	3.9	0.0 E	29
30	-0.1		2.8	10.1	13.7	19.8	20.5	22.5	13.4	8.2	3.0	0.0 E	30
31	-0.1		2.6		15.0		20.2	21.8		7.6		0.0 E	31
TOTAL	10.2	7.3	23.4	146.6	362.7	430.3	660.9	656.8	494.0	338.5	209.2	15.0	TOTAL
MEAN	0.3	0.3	0.8	4.9	11.7	14.3	21.3	21.2	16.5	10.9	7.0	0.5	MEAN
MAX	1.2	0.6	2.8	10.1	19.1	20.5	25.9	24.0	21.6	13.5	9.1	3.0	MAX
MIN	-0.1	-0.1	-0.1	0.9	7.7	11.3	19.1	18.7	13.4	7.6	3.0	0.0	MIN

SUMMARY FOR THE YEAR 1977

MEAN WATER TEMPERATURE, 9.2 DEGREES CELSIUS

MAXIMUM DAILY WATER TEMPERATURE, 25.9 DEGREES CELSIUS ON JUL 21

MINIMUM DAILY WATER TEMPERATURE, -0.1 DEGREES CELSIUS ON JAN 6

E-ESTIMATED

8.3 TGRAPH Output Cards

(a) "Updating Correction" card (79-025) punch

These cards can be obtained by putting a "c" in column 21 of the "TGRAPH Options" card (79-024). If only one part of the available data are to be punched out, then the date of the last required day is entered in columns 22 to 32 of the "TGRAPH Options" card (79-024).

(b) Daily Mean Water Temperatures card (79-102) punch

It is possible to have daily mean water temperatures punched out onto cards which will be sent to Ottawa to update the TEMPERATURES file. These cards can be obtained by putting a "1" in column 21 of the "TGRAPH Options" card (79-024). The daily values on these cards are packed to eliminate blanks and are separated by plus signs, "+".

(c) Daily Maximum, Minimum and Mean Water Temperatures card (71-102) punch

It is possible to have daily mean water temperatures with daily maximum and minimum water temperatures punched out onto cards which will be sent to Ottawa to update the TEMPERATURES file. These cards can be obtained together by putting a "2" in column 21 of the "TGRAPH Options" card (79-024). The different type of daily values are punched on separate card and in month group. The daily values on these cards are packed to eliminate blanks and are separated by plus sign.

The card format for the daily water temperatures (Maximum, minimum and mean) is as follows:

Daily Water Temperatures Cards (Format 71-102)

Column(s)	Description
1	type of daily water temperature U for daily mean water temperatures V for daily minimum water temperatures X for daily maximum water temperatures
2	Region codes, 2 - Vancouver 6 - Montreal 3 - Calgary 7 - Halifax 4 - Winnipeg 8 - Regina 5 - Guelph
3-9	station number
10-12	three digit year, i.e. 979 for 1979
13-15	alphabetic month, i.e. SEP for September
16-17	numeric day of the month, i.e. 03 for the third day
18-20	blanks
21-80	the daily water temperature values with their symbols in a "free form" packed format. The values for each day are separated by a plus sign, "+".

Examples of the Daily Water Temperature, output cards are as follows:

```
U701ED007977JAN 1   0.0+0.0E+0.0E+0.0+0.0+-0.1+0.0+-0.1+-0.1+0.0+0.0+0.3+0.5+
U701ED007977JAN14   0.9+0.8+0.9+0.7+0.8+1.0+1.2+1.1+1.0+0.8+0.5+0.3+0.1+0.0+
U701ED007977JAN28   -0.1+-0.1+-0.1+-0.1+
```

The U in column 1 indicates that the daily values are mean water temperatures and in the present case only daily mean were punched (punch "1" in column 21 of the options card). The first card contains the daily mean water temperatures from January 1, 1977 to January 13, 1977. Similarly January 14-27 are on the second card in the example and January 28-31 are on the third card. The water temperature on January 2 and 3 were estimated as noted by the symbol E.

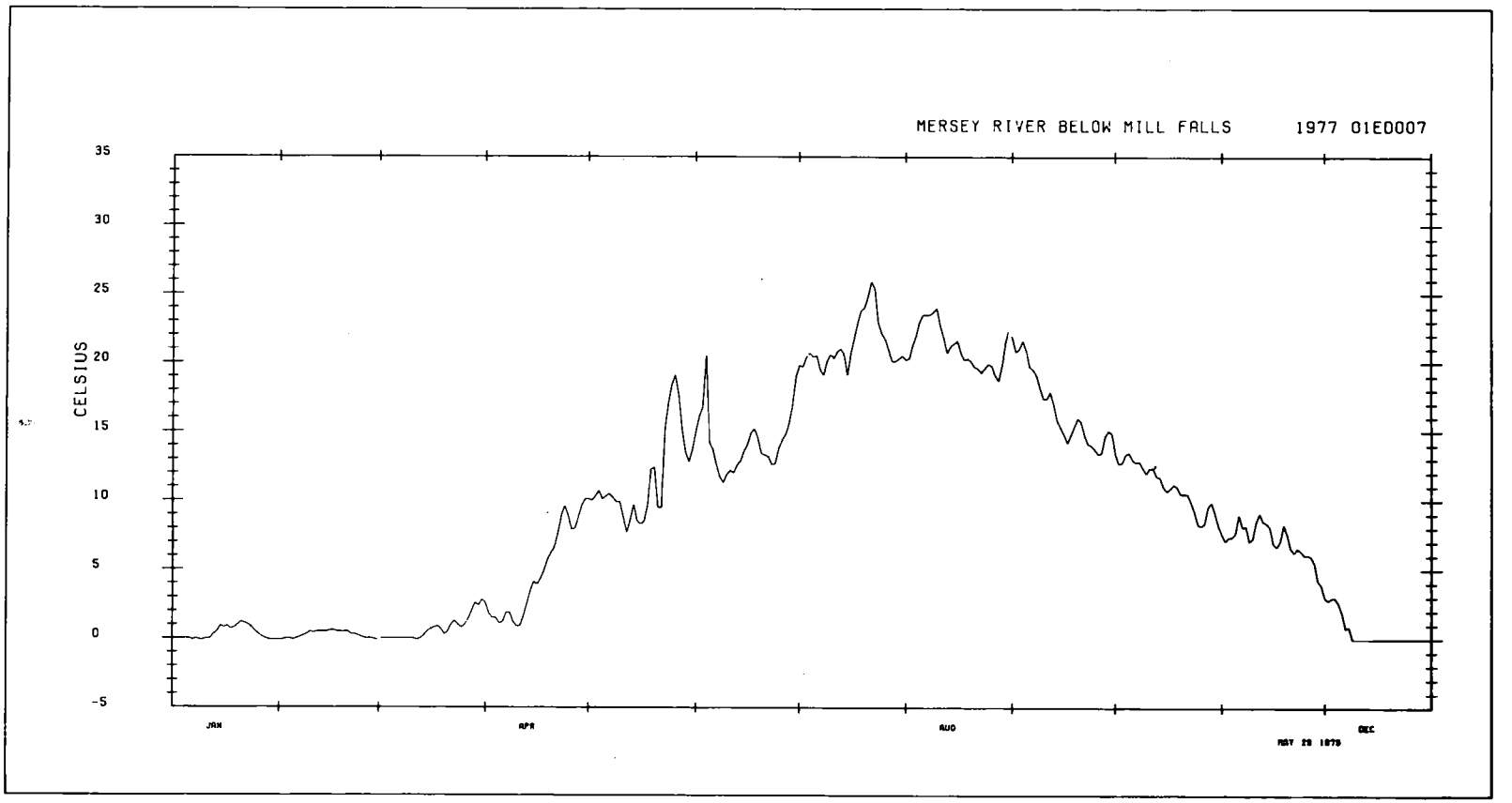
In the next example we have a punch of all daily figures for five months

```
X701ED007977JAN 1   0.1+0.2+0.1+0.1+0.0+0.0+0.1+0.0+0.0+0.0+0.1+0.4+0.7+1.2+1.0+
X701ED007977JAN16   1.2+0.8+0.9+1.1+1.4+1.2+1.0+0.9+0.6+0.5+
V701ED007977JAN 1   0.0+0.0+-0.1+-0.1+-0.1+-0.1+0.0+-0.2+-0.1+0.0+0.0+0.0+0.3+
V701ED007977JAN14   0.7+0.6+0.7+0.7+0.8+0.9+1.0+1.0+0.9+0.6+0.5+0.2+
U701ED007977JAN 1   0.0+0.1+0.0+0.0+0.0+-0.1+0.0+-0.1+-0.1+0.0+0.0+0.3+0.5+0.9+
U701ED007977JAN15   0.8+0.9+0.7+0.8+1.0+1.2+1.1+1.0+0.8+0.5+0.3+
X701ED007977MAR25   3.8++++3.2+3.7+3.2+
V701ED007977MAR25   3.2++++2.2+2.1+2.4+
U701ED007977MAR29   2.4+2.8+2.6+
X701ED007977APR 1   2.4+2.2+1.8+1.7+1.4+2.6+2.3+1.6+1.0+1.4+2.4+3.4+4.2+4.4+4.5+
X701ED007977APR16   5.2+5.9+6.7+7.2+7.7+8.9+10.0+9.9+9.4+8.2+8.2+9.7+10.3+10.9+
X701ED007977APR30   10.8+
V701ED007977APR 1   1.3+0.8+1.3+0.5+1.0+1.2+1.6+1.0+0.8+0.5+0.9+1.9+2.6+3.9+3.4+
V701ED007977APR16   3.5+4.1+4.8+5.3+5.6+6.4+8.1+9.4+8.2+7.7+7.8+8.1+9.2+9.4+9.5+
U701ED007977APR 1   1.8+1.5+1.5+1.1+1.2+1.9+1.9+1.2+0.9+0.9+1.6+2.5+3.4+4.1+3.9+
U701ED007977APR16   4.3+4.9+5.7+6.2+6.6+7.6+8.9+9.6+8.9+7.9+8.0+8.8+9.6+10.1+
U701ED007977APR30   10.1+
X701ED007977MAY 1   11.6+11.2+11.4+11.0+11.7+11.5+10.7+10.7+10.8+10.7+8.0+10.4+
X701ED007977MAY13   10.4+9.4+8.8+8.8+
V701ED007977MAY 1   8.9+9.4+10.1+9.1+9.0+9.9+10.0+9.1+9.0+7.8+7.4+7.4+9.4+8.1+
V701ED007977MAY15   7.9+8.3+
U701ED007977MAY 1   10.0+10.3+10.7+10.1+10.3+10.5+10.2+9.9+9.9+8.8+7.7+8.6+9.7+
U701ED007977MAY14   8.5+8.3+8.5+
```

The first card has the punch X in column 1 and indicate daily maximum water temperatures for January 1979. The next one contains for the daily minimum water temperatures. The next one contains the daily mean values. Daily values are punched in group (Maximum, minimum or mean) and by month.

8.4 TGRAPH Output Plots

A plot of the digitized points of the thermograph curve can be obtained by placing a code of "D" in column 33 of the "TGRAPH Options" card (79-024). The plotting is done in such a way that for each chart orientation there is one plot created which is as large as the working area of the digitizer table. Thus every point that is digitized on the table is also plotted. At the beginning of each plot the letters WSC are drawn. For each new chart, immediately below this, the contents of the chart initial orientation stamp are drawn. Following this the six orientation points are marked by plus signs. At the lower right hand corner of the plot a similar plus (+) sign is also drawn as part of a check for mechanical slippage on the plotter. All the points obtained while digitizing the thermograph curve are joined together and a small vertical bar is drawn at each reference point together with its code. Lastly, the symbol X is drawn at the same location as the plus sign, check point, in the lower right hand corner of the plot. If there has been no mechanical slippage the symbol X will be drawn directly over the plus sign to create a star symbol. If the X and + do not have the same centre the amount of slippage in either direction can be detected. The linear daily mean water temperature graph can be obtained by placing a code of "1" in column 34 of the "TGRAPH Options" card (79-024). All daily mean water temperature for the year will be plotted on a graph of 366 x 160 millimetres. The temperature range is between -5°C and 35°C. The X scale is 1 mm per day.


MERSEY RIVER BELOW MILL FALLS 1977 01ED007
CELSIUS
35
30
25
20
15
10
5
0
-5
JAN
APR
AUG
DEC

8.5 TGRAPH Quality Checking

(a) Ensure that each line in the Updating Correction Table contains the proper temperature and/or symbol and that the correct date has been entered. These updates are of importance because they override the data as computed from the charts.

(b) Examine the Reference Point Summary. First, check the maximum error in the orientation, which is given in the line with "NEW CHART" or "RE-ORIENT" at the beginning. If the following error message appears that section of chart should be re-digitized:

20 *** MAX ERROR LARGER THAN fff.fff AAAA ***

Large errors in orientation may be due to reading one of the orientation points at noon instead of zero hour on the chart or not reading the first orientation point at zero hour on the day indicated in the "Chart Initial Orientation" card (79-027).

(c) Examine the time and paper corrections printed for the Reference Points under the heading at the top of the page "Chart Corr". The cause for any large corrections should be determined before the daily data are accepted. Remember that no paper correction will be shown for the first Reference Point even if the point has been plotted differently than indicated by the "observed readings". This initial difference will be compensated for as explained in "Examples of Chart Documentation" under the section "Time and Paper Corrections".

At the same time one is looking at the chart corrections, one should be looking for any special messages, such as:

"CHECK ABOVE POINT FOR OBSERVED READINGS"

Such messages do not necessarily indicate that an error has been in digitizing but only that an unusual situation has been found.

(d) Another person should check the interpretation of the original chart and compare the data for the Reference Points stamped on the chart with that for the Reference Points shown in the output listing.

(e) Determine the cause of missing data on the (Preliminary) Daily Mean Water Temperature page. Sometimes, to explain the situation, the following message will appear at the bottom of the 12 months of Daily Mean Water Temperature values.

***** SEE LISTING OF DETECTED ERRORS ON NEXT PAGE *****

The following statement describes the usual detected error.

*** JUL 8 1977 11-23 DIFF. IN TEMPER. = FFFF.F DEGREES, BREAK IN RECORD NOT BRIDGED

This message indicates that the point which corresponds in time to 1123 on July 8, 1977 is the first point after a break in the record. This point is usually the first point on a new chart segment. Although the time associated with this point agrees with that of the point on the other side of the break, the difference in temperature between the two points is greater than 2.0 degrees celsius. Thus the points are not joined and the data for the day will be -99.9.

(f) The statement * THIS IS THE NEXT READING * should be given some attention as it indicates that the first point read after the orientation was not a reference point. This message may appear in two places:

(1) immediately following the line "NEW CHART";

When the message appears after this line, it indicates that the first point read on a "New Chart" segment was not a reference point. This is unusual, and may indicate that the operator forgot to place a reference code on this point. Thus this affects the application of chart corrections and the temperature for the "Chart Reading" will be -99.9.

(2) immediately following the line "RE-ORIENT":

It is a normal occurrence for the statement to appear after this line as it indicates that the first point read after the chart re-orientation was not a reference point. The temperature will be -99.9 if no check point has been encountered before the re-orientation. If a check point has been encountered, the value of the temperature will be corrected under the assumption that the correction is the same at the code 8 reference point as at the last check point.

(g) Compute the daily temperature manually for one day for each set of orientations, (an orientation would usually start with a code of 1 and end with a code of 8; start with a code of 8 and end with a code of 8 or start with a code of 8 and end with a code of 9).

Other statements that may be found in the "Reference Point Summary are:

*** CHECK ABOVE POINT FOR OBSERVED READINGS ***

This message indicates that the "Reference Point" card (79-028) contained no observed data. Observed data is expected for the first reference code of 1 after an initial orientation, a code of 6 or a code of 9 at the end of a chart segment. This is only a warning message and the program uses the paper and time corrections as computed for the previous check point or as computed for the next point.

*** SEQ. RESET *** CARD NO. NNNN TO FOLLOW CARD NO. MMMM ***

This is a warning message only and simply indicates that a "Sequence Reset Card" (68-012) has been encountered to adjust the card sequence. This message may appear in the "Updating Correction Table" or the "Reference Point Summary".

9. ERROR MESSAGES

This section refers only to errors found by the computer program. Jobs may have been terminated because of computer system errors such as control card errors or invalid characters not checked by the computer program, these should be resolved with a system analyst from the local Computer Centre or by contacting the Data Control Section, Ottawa.

The program cannot directly recognize the different types of cards that make up the input deck. When the input cards are in the correct sequence the program reads the cards correctly because each card tells the program what type of card to expect next. If some cards are missing, mispunched or are misplaced the program will normally print the correct error message and point to the source of error. However, the error in question might cause the program to make the wrong assumption about the card following the one that is in error and issue error messages for cards that would normally be correct had the original error not occurred. Whenever the program prints out an error message that does not seem to apply to the card in question, one must go back and find out why the program expected a different type of card.

The following notations are used in the description of the error messages:

(a) NNNN indicates numeric data such as a card sequence number;

(b) AAAA indicates alphanumeric data such as the station number; and

(c) ffff.fff or a similar series of lower case letters represent figures computed by the program.

Although the error messages for the TGRAPH PROGRAM are similar to those for the STREAM PROGRAM there are two significant changes:

(a) A time difference of 2 hours is allowed between two reference points, ie: 9 code and 1 code

(b) A variation in temperature between two reference points should not be greater than 2°C, ie: 9 code and 1 code.

The following is a list of error messages and their designated message numbers that may appear in the "Updating Correction Table" or "Reference Point Summary" output listing.

Messages 8, 10 through 19, 28 and 31 are not applicable to TGRAPH. If an explanation is required, refer to "Automated Hydrometric Computation Procedures" October, 1977.

1 *** INVALID DATE CARD *** AAAA AAAA AAAA AAAA

The 16 A's are a copy of the contents of columns 1 to 16 of the first card.

This message indicates that columns 1 to 4 do not contain the word "DATE". The TGRAPH program assumes that columns 5 to 16 contain a valid date and use the contents of columns 5 to 16 for the date on the output listings. Therefore this card must be checked carefully.

2 *** PROCESSING TERMINATED DUE TO ERRORS ON THE OPTIONS CARD ***

The various options which were requested on the "Options" card (79-024) are listed. If there is an invalid option in one of the fields, it will be identified by three asterisks and the above message will appear below the table. This will also include a check for invalid characters and date errors. This is a critical error message and processing for this station will terminate after the "Options" card (79-024) has been edited.

3 *** WRONG STATION NO. AAAAAAA ON THE AAAA AAAA CARD ***

This message indicates that the station number AAAAAAA on the "Options" card (79-024) is not the same as the one given on the "Station Name" card (76-002).

This is a critical error if it occurs in the "Options" card (79-024) and all processing for this station will terminate after this card has been edited.

4 *** NNNN WRONG STATION NO. AAAAAAA ***

This message may appear within any of the tables or summary listed below and indicates that the station number on card NNNN is not the same as the station number on the "Station Name" card (76-002). This is a critical error and if printed in the:

(a) Updating correction table, none of the updating corrections will be applied, but processing of other data will continue; or
(b) Reference point summary, daily data will not be computed for that chart segment.

5 *** **** WRONG STATION NUMBER ON SEVERAL CARDS ***

If the station number on four or more cards within a table or summary is not the same as the station number on the Station Name" card (76-002), this message will appear only once within that table or summary. It has the same effect as error message 4.

6 *** NNNN DATE ERROR ***

This message may appear within the table or summary listed below and indicates that the date on card NNNN is in error or the dates in the updating correction table are not in chronological order. This is a critical error and if printed in the:

(a) Updating correction table, none of the updating corrections will be applied, but processing of other data will continue; or
(b) Reference point summary, indicates that either the "Chart Initial Orientation" card (79-027) or the "Reference Point" card (79-028) is in error and none of the daily data for that chart will be computed.

7 *** SEQUENCE ERROR *** CARD NO. NNNN FOLLOWS CARD NO. MMMM ***

This message may appear within the table or summary listed below and indicates that the cards have been mixed up or that a "Sequence Reset" card (68-012) has been omitted. This is a critical error and if printed in the:

(a) Updating correction table, none of the updating corrections will be applied, but processing of other data will continue; or
(b) Reference point summary, daily data will not be computed for that chart segment.

9 *** INVALID CHARACTER ***

This message appears only in the updating correction table and indicates that one of the following invalid characters has been keypunched in the temperature field or associated symbol field on the "Updating Correction" card (79-025):

(a) Letter instead of digit; (b) Symbol other than "E" (c) More than one decimal points;; (d) One or more plus or minus signs; (e) Sign or decimal point but no

data; or (f) Embedded blank or following blanks (this occurs if a temperature value has not been right justified).

20 *** NNNN MAX. ERROR LARGER THAN fff.fff AAAA ***

This message indicates that the error in orienting the chart is larger than the allowable error, fff.fff. in inches or metres and the chart should be re-digitized. Processing will continue to expose other possible errors. The maximum allowable error is now set at 0.025 inches or 0.006 metres. The NNNN is the sequence number of the card which contains the digitizer co-ordinates used in the orientation. This card, NNNN, immediately follows either the "Chart Initial Orientation" card (79-027) or in the case of a re-orientation follows a "Reference Point" card (79-028) containing a code 8. This message appears in the Reference Point Summary.

21 *** NNNN OVERLAP WITH PREVIOUS POINT IS fff.ff HOURS *** AAAA AAAA

This message indicates that the digitizer co-ordinates just read overlap, with respect to time, the immediately preceding co-ordinates. The maximum overlap allowed is two (2) hours. The point that has just been read is always compared to the immediately preceding point, even if that point overlapped its predecessor. The fff.ff represents the overlap in hours. The NNNN represents the sequence number of the card containing the last co-ordinates that were read. The A's represent the date and time of this point. This chart segment must be re-digitized.

22 *** NNNN CODE ERROR ***

This message is generated when the code in a "Reference Point" card (79-028) is not one of 1, 3, 6, 7, 8, or 9. This message appears after the information in the "Reference Point" card (79-028) has been listed.

23 *** **** NO OBSERVED READINGS FOR THIS CHART SEGMENT ***

This message indicates that no observed data were given with the reference point just read, which had a code of "9" (end of chart segment) and that all the reference points since the beginning of the record also had no observed data. Thus there will be no output for this portion of the chart. This message will follow the last reference point in question.

24 *** CLOCK TIME OR DAY OF THIS CHECK POINT IS LESS THAN PREVIOUS CHECK POINT ***

This message means that the day or time of day for the present reference point is less than that for the previous reference point. The day or time of day has been incorrectly punched onto the "Reference Point" card (79-028) and possibly only the one "Reference Point" card (79-028) in error will have to be re-keypunched. With this error message, the daily data from the last check point to the next "Chart Initial Orientation" card (79-027) will not be computed.

25 *** CODE 8 POINT NOT AT ZERO HOUR ON THE CHART ***

This message immediately follows the line of output describing a "Reference Point" card (79-028) containing a code of "8" and means that the point to which the code "8" is attached was not on the zero hour (chart time) of a day, i.e. this point is more than two (2) hours from zero hour. Note that the chart time is used, not the corrected time. Thus daily data will not be computed for the portion of the chart segment between the last check point and the next "Chart Initial Orientation" card (79-027).

26 *** THIS POINT IS NOT THE SAME AS THE CODE 8 POINT ABOVE ***

This message indicates that the first point after a re-orientation is not the same point as the last point before the re-orientation, i.e. there is a time difference of more than two (2) hours between these two points. Thus there will be no daily data for the portion of the chart segment between the last check point and the next "Chart Initial Orientation" card (79-027). This message always follows a message describing the re-orientation.

27 *** **** AA CARD OUT OF PLACE OR CODE 9 MISSING ON OR AFTER CARD NO. NNNN ***

This message refers to one of the following situations:

(a) A "Reference Point" card (79-028) with a code of 9 is followed by a card in which columns 1 and 2 do not contain the code numbers 97 for end of chart segment or 98 for end of station:
(b) A 97, 98, or 99 card occurs before a code 9 "Reference Point" card (79-028) is encountered.

This message prints out AA (for 97, 98 or 99) and the card sequence number of the preceding card, NNNN. The result is that daily data are not computed between the last check point and the next "Chart Initial Orientation" card (79-027).

29 *** ANNUAL PAGE REQUESTED FOR NNNN BUT NO DATA FOR THIS YEAR ***

This message indicates that an annual page was requested for a certain year NNNN in columns 11-14 of the "TGRAPH Options" card (79-024) but that no data were computed for this year. This is a critical error message and all processing for this station will terminate.

30 *** PROCESSING TERMINATED DUE TO CRITICAL ERRORS ***

This warning message will appear at the end of the output listings and indicates that one or more critical errors were found which terminated the processing for this station at a certain point.

32 *** UNIT MM TAPE ERROR FROM MAGIO AFTER NNNN RECORDS ***

MM is the unit number of the scratch file containing the corrected digitized points for one station. This message indicates that the records on the scratch file are out of sequence due to a computer malfunction with the result that the job stops immediately. The Computer Centre should be notified and if it persists, the Data Control Section in Ottawa should be informed.